14

1903

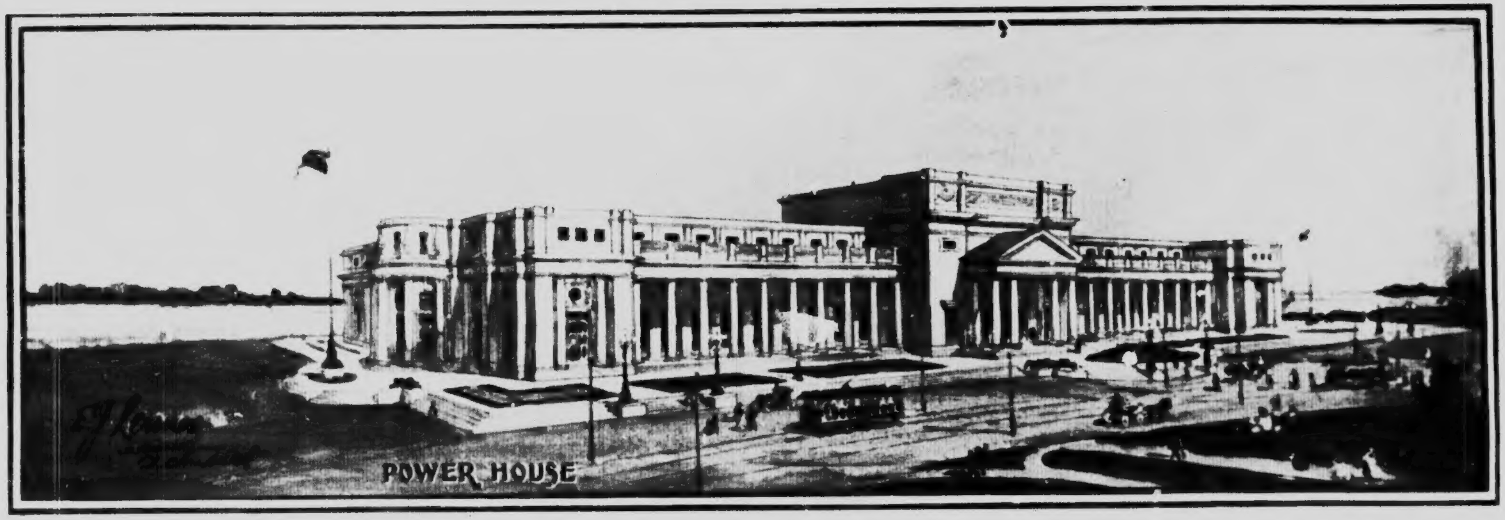
INTERIM REPORT

OF THE

ELECTRICAL DEVELOPMENT COMPANY OF ONTARIO, LIMITED,

AND

TORONTO AND NIAGARA POWER CO.



The Company's franchise from the Government and Park Commissioners contained a condition that the Power House should be of such architectural dignity as not to detract from the appearance of the Park.

The above plan has been submitted to, and finally approved of, by the Government and the Commissioners.

THE ELECTRICAL DEVELOPMENT COMPANY
OF ONTARIO, LIMITED.

The Toronto and Niagara Power Company.

DIRECTORS.

President - - -	COL. H. M. PELLATT.
1st Vice-President and General Manager.	FREDERIC NICHOLLS.
2nd Vice-President, - - -	WM. MACKENZIE.
Hon. GEO. A. COX.	JAMES ROSS.

H. G. NICHOLLS, Ba.Sc., Secretary. D. H. McDOUGALL, Treasurer.

Chief Consulting Engineer, -	F. S. PEARSON, Dr. Sc.
Chief Hydraulic Engineer, -	HUGH L. COOPER.
Chief Engineer, Right of Way, -	W. T. JENNINGS, M.I.C.E.
Resident Engineer, - -	BEVERLY R. VALUE.

Bankers, - THE CANADIAN BANK OF COMMERCE.

Solicitor, - H. H. MACRAE.

To the Shareholders and Bondholders of the Electrical Development Company of Ontario, Limited:

GENTLEMEN,—

In order that the holders of the securities of the Company may be informed regarding the progress made in the development of their properties, I have pleasure in submitting herewith information concerning the organization of the Company, and reports from our chief officials, accompanied by reproductions of such plans, maps and photographs as may make said reports readily understood.

On January 29th, 1903, an agreement was entered into between the Queen Victoria Niagara Falls Park Commissioners and Messrs. Mackenzie, Pellatt and Nicholls, granting rights to take water from the Niagara River at Tempest Point, for the purpose of generating electricity to the extent of 125,000 electrical horse power.

On the 18th February, 1903, the Electrical Development Company of Ontario, Limited, was incorporated by letters patent under the authority of the Legislature of Ontario, with a capital stock of $6,000,000.

At a meeting of shareholders of the Company, held on March 21st, 1903, the agreement made between Messrs. Mackenzie, Pellatt and Nicholls, and the Queen Victoria Niagara Falls Park Commissioners, was acquired by the Company. The following Directors were elected:—Messrs. William Mackenzie, Henry M. Pellatt, Frederic Nicholls, Hon. Geo. A. Cox and James Ross. Subsequently, Col. Henry M. Pellatt was elected President, Mr. Nicholls Vice-President and General Manager, and Mr. Mackenzie 2nd Vice-President. At the same meeting Mr. H. G. Nicholls was appointed Secretary, and Mr. D. H. MacDougall, Treasurer. Mr. F. S. Pearson, Dr. Sc., was appointed Chief Consulting Engineer; Mr. Hugh L. Cooper, Chief Hydraulic Engineer; and Mr. Beverley R. Value, Resident Engineer for the proposed works at Niagara Falls, Ont.

Since that date no time has been lost in expediting operations, in order that the enterprise may be income producing at the earliest possible period. Contracts have been awarded for coffer dam, tail race tunnel, wheel pits and electric generators, and preliminary plans have been completed for the power house building, the front elevation of which will be found illustrated on another page of this report. Contracts for the water wheels and head gates have yet to be let, but the engineering data for all of this work is about completed, and tenders will be called for at an early date.

The Toronto and Niagara Power Company, having the charter right to expropriate lands, has been equally active in securing a private right of way between Toronto and Niagara Falls, on which the pole line for the transmission of energy will be constructed. About 85 per cent. of the right of way, having a minimum width of 80 feet, has been purchased to date. Mr. W. T. Jennings, M.I.C.E., was appointed Engineer in Chief of this work, which has been conducted with ability by himself and his staff of assisting engineers.

The right of way has been located in such manner that in addition to the pole line, provision is made for a double track railway, should future developments warrant its use for such an enterprise.

The report of the Resident Engineer refers to some of the difficulties which have been met and overcome, and it is cause for congratulation that it has been demonstrated that the conception of materially shortening the tail race tunnel by constructing it under the bed of the river is entirely practicable.

With a view to providing manufacturing sites for those who may become purchasers from the Company of power for industrial or electro-chemical uses, some 530 acres of land have been purchased fronting on the Chippewa River, situate about two miles from the Town of Niagara Falls, three miles from the confluence of the Chippewa and Niagara Rivers, and about 3½ miles from the point at which the Chippewa River has entrance into the Welland Canal. These lands have a river frontage of over 1½ miles. The purchase price averaged about $70.00 per acre. The wisdom of this early purchase is evidenced by the fact that similar lands in the vicinity are now held at a great advance over this figure, caused no doubt by activity due to the development works at Niagara Falls.

Instalment payments on the Company's bonds have been promptly met and receipts have, up to the present, been in advance of expenditures. The cash balance at the credit of the Company, in the hands of the National Trust Company, trustees for the bondholders, amounts at this date to about $1,000,000. As all the works of the Company are being pressed forward to completion simultaneously, progress payments will be required more rapidly in the future, but calls have been so arranged that ample funds will be available to meet all expenditures as the work progresses.

I have the honor to be,

Yours faithfully,

FREDERIC NICHOLLS,

Vice-President and General Manager.

CONSULTING ENGINEER'S REPORT.

New York, December 12th, 1903

Mr. Frederic Nicholls, Vice-President and General Manager,
Electrical Development Company of Ontario Toronto, Ont.

Dear Sir,—In accordance with your request I beg to submit the following report of progress on the construction of your power plant at Niagara Falls.

At the time this work was commenced it was recognized by all those conversant with the plans that the greatest difficulties the company would have to encounter would be in the installation of the coffer dam and the commencement of the work on the main tail race tunnels. It was considered by many that it would be impossible to carry out the work as outlined on the original plans. I am glad to say that both of these serious problems have been solved in a very satisfactory manner and without serious expense or delay.

It was assumed in the original estimates that the depth of the water would be about 8 feet as a maximun on the line of the coffer dam, and in view of the fact that this dam was to be located in the midst of the rapids of the Niagara River it was expected that it would be a difficult operation to build a structure that would withstand the excessively rapid current. As the work on the coffer dam proceeded and it became possible to ascertain the depth of the river, it was found that there was 26 feet of water, but even with this extraordinary depth and the rapid current, the work on the dam has proceeded continuously and at a rapid rate when the difficulties of construction are considered.

The most serious part of the work is now completed and there remains only a short spur to connect with the shore in shallow and still water. The dam as constructed is thoroughly stable and secure, as one cannot feel a tremor in any portion of the work and it is evident that the dam is well designed for the purpose intended.

A long section of this dam was constructed over a portion of the river bed covered with very large boulders, on which it was necessary to place the coffer dam, fitted to the boulders as well as was possible under the conditions. Naturally a coffer dam built on such a sub-stratum would show great leakage, and it will require considerable work and time to stop the flow of water under the dam. An inspection of the work at the present time shows that very little water is leaking under the dam, even between these boulders, and there is no reason why the greater portion of these leaks should not be stopped. At the present time the amount of water coming through under the dam is not sufficient to seriously interfere with the construction of the work, as it could be handled by flumes and canals if necessary. The larger portion of these leaks, however, will be stopped in the next few months, and before the fore bay construction is commenced.

Considering the rapid current flowing at the face of the dam and the great depth and rough bottom upon which it was constructed, the contractor for this dam and your resident engineer, Mr. Value, are entitled to a great deal of credit for the masterly way in which this work has been handled, as it can be safely stated that this coffer dam represents as great an undertaking in this line of work as has probably ever been designed or constructed.

The plan for the tail race tunnel requires a portal under the Falls. There have been various theories regarding the condition under the Falls, as there are, at times, noticeable explosions, apparently, due to compressed air, and it was confidently predicted by engineers, conversant with Niagara Falls and the work thereabout, that it would be impossible to open a tunnel portal at the point selected on the plan. In order to reach the line of the main tunnel a subsidiary tunnel of about 650 feet in length was required, and to ascertain the conditions under the Falls, as well as to provide for dumping the *debris* of excavation, an opening was planned about midway of this tunnel. It was anticipated that some trouble might be caused by the water when this opening was made, and the anticipations were more than borne out by the facts, as long before an opening was effected the subsidiary tunnel was flooded with water which leaked through cracks at the face of the cliff. For several weeks the contractor had a great deal of trouble in overcoming this difficulty, but finally, after persistent and very creditable work, an opening was effected, which has completely drained the tunnel, and also proven that it is perfectly feasible to place the terminal of the main tail race tunnel at any point we desire.

The character of the rock encountered in the subsidiary tunnel is a solid shale, thoroughly tight, and there is not water enough in the tunnel to supply the air drills. In most places the rock is absolutely dry. This is an indication that we shall have no trouble in driving our main tail race tunnel, especially in view of the fact that there is now an opening from the subsidiary tunnel which would drain any volume of water which might come in through a fissure in the rock.

As stated in the beginning, with this opening under the Falls assured, and the coffer dam practically completed, I feel that the two greatest difficulties, in connection with this work, have been surmounted. The progress of the subsidiary tunnel (something like 14 feet per day) is an indication of the progress the contractor should make on the main tunnel.

The contractor for the wheel pit is erecting a large and efficient plant for the construction of this pit, and it is evident that he proposes to push this work in every possible way.

On account of the magnitude of this installation, and the immense volume of water required for its operation under maxim conditions of load, there has been a question in the minds of the engineers as to the volume of water readily available for the work. This question arose from the assumption that the maximum depth of the water in front of the fore bay was only about 8 feet. As you are aware, plans were under consideration contemplating the excavation of a deep channel in the river beyond the coffer dam limits to provide for a sufficient volume of water. Now that the coffer dam is installed, and the great depth of 26 feet of water has been found, all questions regarding the supply of water have been set at rest, as it is evident that the amount of water available is several times in excess of that required.

While the great depth of the channel has made the construction of the coffer dam much more expensive, it avoids a large expenditure in excavation and absolutely assures the company as regards its water supply, thus compensating for the greater cost.

The plans for the work in general are being completed and contracts have already been placed for the wheel pit, tail race tunnel and generators. The plans and specifications for the water-wheels and iron work about the power station, and pole line, will soon be ready, so that the contracts for these can be placed within a few weeks.

The location of this plant is very advantageous and I feel confident that when completed it will be equal in all respects to any that have been proposed or constructed at Niagara Falls. On account of its advantageous location the cost per horse power will be exceptionally low. With a transmission line to Toronto of capacity sufficient to deliver 30,000 H.P., the total cost per delivered horse power at Toronto will be as low, if not lower, than that for any other plant of a similar nature that has been constructed.

The company should also build up a large business in the vicinity of Niagara Falls and along its transmission line, and with the low initial cost, the financial success of the company seems assured, as on account of the low cost of its power, it should be in a position at all times to meet competition with other concerns and at prices which will realize a good net income.

I have not enlarged upon the details of the work at Niagara Falls, as the report of your resident engineer fully covers these points.

Yours very truly,
F. S. PEARSON, Dr. Sc.,
Consulting Engineer.

CHIEF HYDRAULIC ENGINEER'S REPORT.

FREDERIC NICHOLLS, ESQ., Vice-President and General Manager,
14-16 King Street East, Toronto, Ont.

Dear Sir, Complying with your instructions requesting a brief statement covering the engineering and economic conditions that obtain with reference to our plant at Niagara Falls, Ontario, I beg leave to submit the following:—

GENERAL STATEMENT.

Water power as applied to mechanical or electrical transmission is valuable in degree as fundamental elements are reliable and economical. For reliability, water power must first be possessed of soundness of foundations upon which to build structures. Secondly, reliability must depend upon the question of water supply. In a third sense, this question should be discussed upon the reliability of the design that is to occupy the foundations and that is to use the water. A succeeding important element that must necessarily be discussed is the cost of operation of the plant and its intelligent upkeep.

The foregoing four elements may be regarded as of fundamental importance in the selection of a site for a water power, and as success is attained in fulfilling the requirements of the foregoing four principles, the element of economy is in relative degree obtained.

Upon the question of economy, it should be accepted as fundamental in any industrial enterprise, that the undertaking must be so founded as to be able to show profit under the most severe demands of competition. If the enterprise is installed with the foregoing capacity, it becomes as such a dominant factor in the field of competition and is qualified thereby to, in a large measure, regulate prices and the field of territory which it will occupy, and so produce satisfactory dividend returns.

SELECTION OF SITE.

The selection of the site was attended by a careful study of the conditions that have obtained for the last six years in heavy water power installations, and particular study has been given to the present plants now in operation and under way both on the American and Canadian shores, both above and below the falls at Niagara. The installations of the Niagara Falls Power Company on the American side have been on a large scale, and the demonstrations made by the foregoing company have been of particular value in the selection of your site.

The construction of a deep vertical wheel pit and the discharge of the water therefrom by the use of a low level tail race tunnel have been demonstrated as successful designs applicable to the geological conditions that exist at Niagara.

It is admitted by all that enterprises of the magnitude here under consideration cannot be so designed that the completed result is an absolute and entire success, and the Engineering Department of your company do not promise that the finished plant, constructed upon the lines now laid down, will reach perfection, but rather that infirmities developed in previous similar work will be corrected. That the plant, as located and designed, will be a better plant than has hitherto been constructed is a result that the stockholders should be safely justified in expecting.

In the selection of the site chosen, special weight was given to the fact that the low-level tail race tunnel and the wheel pit on the American side have proved an entire success, as far as feasibility and permanence of construction apply.

One of the serious conditions that exist at Niagara Falls is the ice question, and the site selected is believed, for reasons hereafter explained, to offer less trouble from ice than any of the plants hitherto constructed or now under process of construction at Niagara. In the preparation of the designs that are now being followed for the construction of your plant, the site selected has afforded every opportunity for the construction of a plant that will provide the elements set down in the foregoing general statement as necessary for said results, and the territory secured from the Government does not offer to the engineer serious obstructions or expensive designs. The length of the tail race tunnel in your plant is 450 feet shorter than the shortest of the two existing tail race tunnels at Niagara Falls, and has, added to this, the advantage of being without curvature. The location of the power house in its present position is a particular advantage, when consideration is given to the expense and difficulty of operation attending where the power house is situated in close proximity to the constant humidity existing close to the Falls proper.

The selection of the site has resulted in the securing of an operating head of at least 15 feet greater than that obtained by the Niagara Falls Company, either on the American or the Canadian sides. The value of these 15 feet of extra head finds particular expression in the fact that each foot of increased head serves to reduce the cost per H.P. of the hydraulic and electrical apparatus. The reason of this is found solely in the higher spouting velocity due to the increased head.

In dismissing this portion of the discussion it is not amiss to say that one of your principal assurances should be found in the fact the design employed does not invade the field of experiment, but rather follows precedent, with such improvements as are dictated by past failures and partial successes.

GENERAL DESCRIPTION OF DESIGNS.

A brief general description of the design adopted requires the following statements:

In order to appropriate to the permanent use of plant a reliable quantity of water, the gathering dam shown on the plans has been designed, the purpose of which is to introduce upon the bed of the Niagara River a gathering dam, opening up the stream, and at the mouth of which dam there shall always be an area that will naturally receive a sufficient amount of water for the necessities of the plant, and at the same time divert these waters to the conduits leading to the wheel pit. In the location of this gathering dam, due consideration has been given to the natural currents of the river and to the small changes that may result in the same due to the construction of the works of the Ontario Power Company situated above our site. The gathering dam above referred to will be built of masonry, properly founded and so designed that the possibility of future attention to this structure should be dismissed.

This gathering dam changes the original rapids in front of the site into a ponded condition and raises the old water level approximately 18 feet under normal conditions. Connecting to this gathering dam and a part thereof, will be constructed a system of masonry diverting booms with submerged orifices, the office of all of which will be to divert approaching ice and debris to suction weirs and overflow capacities provided for in the crest of the gathering dam. The manipulation of ice and debris is best accomplished where the structures involved offer the least obstruction to the ice, and in the designs adopted the gathering dam and diverting booms will be so nearly parallel to the direction of the flow of the Niagara River as to reduce annoyance of this kind to a minimum. The point of land above our intake is so situated as to in itself act as a huge natural fender in the diversion of ice from our headworks

The water thus gathered will be conveyed downward through steel tubes to the water wheels located in the bottom of the wheel pit, and the differences of level provided by the design are such that, after deducting losses from friction and the velocity of approach and discharge, there will remain an operating head of 143 feet to be used by the turbines. In order to obtain this operating head the design calls for the construction of the wheel pit through solid rock, as shown on plans. This wheel pit is provided with masonry lining as shown, and the provision that the turbines and all of the machinery above them shall rest upon solid rock foundations, instead of artificial supports as has hitherto been the practice, is an element newly adopted for this construction, and the value of this provision is self-evident.

The eleven generators provided for in the complete plans will be installed on masonry foundations at the level of the power house floor, as shown on the drawings, and the connection between the generators and the turbines at the bottom of the wheel pit will be made by the use of a hollow shaft, traveliing in a vertical position, and having a total length of approximately 115 feet, supported at three intermediate points by solid masonry bearings, as shown on the drawings.

The two elements in the wheel pit of placing the labor of supporting all of this machinery upon solid rock foundations, and the provision of masonry intermediate supports for the shafting, are a departure from previous practice, but have been adopted in order that the serious element of vibration in heavy revolving machinery may be reduced to an absolute minimum, and the expense of upkeep thereby have its proportionate reduction.

The water, after the performance of its labor in the turbines, will be discharged through steel draft tubes to two branch tail-race tunnels connecting with the upper end of the main tail-race tunnel. This design is also a departure from previous practice, but has been adopted for two important reasons: In the first place, it is not to be assumed that machinery can ever be so installed as to remove the necessity of future repair. By the use of the two branch tail-race tunnels, as designed, it will be possible at any time to close down one-half of the station and make any necessary repairs without the other half of the station being interfered with. In other words, the use of the two tail-race tunnels designed, in practice makes two stations of the one station, each half being absolutely independent of the other. This provision also is important because in active operation, if the design permits, it is always desirable to make frequent examinations of the machinery in order that the beginnings of trouble may be discovered before serious expense has accumulated. This design will permit of weekly examinations of each half of the station at nights when the peak loads are off, and at any time when the loads are such that one half of the station can carry them.

Another important value in this design of discharge is that the turbines themselves will always be accessible and not be submerged at times as in other plants, and as such their care can have intelligent supervision.

It has occurred in the Niagara River, below the Falls, that jams of ice have temporarily caused more than 50 feet of an increase in the ordinary high water level below the Falls. When your plant is in operation, if such a condition should exist, the only result will be a reduction in the operating head during the temporary period, and not the filling up of the turbine chamber and its consequent inaccessibility and damage.

The water, after it is delivered to the branch tail-race tunnels, is by them conducted to the main tail-race tunnel which here originates, and the same from here continues in a straight line and with a grade of 5½ feet in a thousand to a point of discharge behind the main sheet of the Falls, as is shown by the plan. This tunnel, in being straight, is free from special erosion to its lining due to a change in direction of rapidly moving water. The tunnel will be built with the section shown on the drawings, and the specifications require that the character of the masonry to be placed in the lining shall be such that there can be no reasonable possibility of expense or annoyance due to its use.

An elaborate set of careful tests are being made by your Engineering Department of all of the materials that enter into the linings of the tunnels and the whe[illegible] in order that we may not be deceived in securing for the finishing plant, the very best of material. The contracts let for permanent works up to this time have been let to contractors of responsibility, and from them the Engineering Department is confident in expressing the belief that the workmanship in the use of these specially tested materials, will unite to bring out a finished structure of approved permanency

In the design of the tail-race tunnel, due consideration has been given to the fact that the Horseshoe Falls are continually receding, and the linings are provided for a distance of 300 feet from the lower end, with lining rings six feet in length, in order that, as the Falls recede and the tunnel shortens, its length may be shortened by the dropping off of the lining in uniform sections, thereby preventing the cracking of the linings back of the portion shortened. The design of the tail-race tunnel also provides for the construction in the crown of the arch of an observation gallery, by the use of which it will be possible for inspection of the entire length of the tunnel arch to be made at stated periods. This provision is impossible in designs previously adopted.

The recent completion of the construction shaft by Contractor Douglass and the opening from the same through the wall back of the water column, has proven that the conditions existing behind the main sheet of the Canadian Falls are entirely normal and that the plans adopted should be successful. The character of the material encountered in the sinking of the construction shaft tally with the geological formations encountered both on the American and Canadian sides, thus forbidding apprehensions as to what will be encountered in the boring of the main tail-race tunnel.

The construction of the Barry & McMordie coffer dam has uncovered a sufficient amount of the river bottom to prove that the foundations are in solid limestone. While the pressures due to the construction of the gathering dam and the foundations of the power house are in no wise excessive—not in any case being over five tons to the square foot it is gratifying to know that the materials encountered would be entirely satisfactory if the pressures resulting were as great as twenty-five tons to the square foot. There is no reason to believe that the foundations for all the masonry involved in the design will at any place be inadequate or troublesome; neither should special designs for the strengthening of foundations or change in the designs caused by inferior foundations be brought to your attention.

WATER SUPPLY.

The Treaty of Ghent fixes the boundary dividing the waters of the Niagara River into two portions of national ownership. Gaugings of the entire dischare of Lake Erie into the Niagara River, made by the United States Government, indicate that the low water flow of the Niagara River may be as low as nine million cubic feet per minute. From an examination of the velocity of the water along the Canadian shore, and based upon the depth of the water directly in front of our gathering dam as shown by the coffer dam now built, it is demonstrated that a much larger percentage [illegible] the total flow of the Niagara River is owned by the Canadian

Government. It is probable that this amount may be 65 per cent. of the total flow of the Niagara River. In the foregoing statement the natural depths of the water are only estimated and not the present depth due to the piling up effect from our coffer dam.

The plans now provided for call for a sufficient amount of water for the operation of 125,000 H. P. under the head that can be assured from your site. Basing the turbines as having an efficiency as low as 75 per cent., our requirements will be, approximately, 700,000 cubic feet of water per minute to pass to turbine discharges.

The design and extent of the gathering dam, and its actual location, may be criticized from the point of view that the same will gather more water than now needed. The construction of the coffer dam has proved that the water, as naturally flowing, was at least 150 per cent. greater in depth over the territory that will be occupied by the gathering dam than was first estimated. This excess area has called for a considerable increase in the cost of the coffer dam, but this increase will be practically offset in the reduction of the amount of excavations necessary and other advantages accruing.

It now seems that, with the present power consumptions at Niagara, our gathering dam, under the most adverse conditions, will seize at least 1,800,000 cubic feet of water per minute, instead of the 700,000 cubic feet per minute needed. The above calculations have been made with due regard to the full development by the Ontario Power Company of their concession rights, and with the possibility of the subtraction of 100,000 H.P. additional to present consumptions on the American side. The reason of this is found in the fact that serious discussions are in existence, both on the Canadian and American sides, all having to do with a reduction of the amount of water that may ultimately flow over the Horseshoe Falls. It is seriously discussed that a deep waterway from Lake Erie to the sea shall be built. It is also seriously discussed, from time to time, the construction of a ship canal from Lake Michigan to the Mississippi River. Chicago also has the right to take an additional 300,000 feet of water per minute from the great lakes for the purpose of drainage to the valley of the Illinois and Mississippi Rivers. Succeeding legislatures and governments may grant further concessions for electric power developement from the Niagara above our intakes.

In view of the foregoing possibilities, and others which may arise and not now thought of, the wisdom of a gathering dam of so large a capacity would be urged upon you if the suggestion was made that economy should be introduced into the design by reducing the extent of the gathering dam.

In conclusion, I would say that the Engineering Department are of opinion that the water supply, as above noted, should be kept as it is, for the reasons mentioned.

DESIGN OF STRUCTURES.

Under this heading there is little to be said outside of the statements made in the general description of the plant. The structures throughout the undertaking have been designed upon the basis dictated by the best requirements of modern practice, and if there had been any departure from said demands it has been in the direction of increasing the ratio of safety. The use of perishable material has been ignored and prohibited in the specifications, and throughout the work inaccessible par [illegible] so designed that they are self-sustaining, and without need of future attention or rep [illegible] The use of units of 12,500 H.P. (eleven in number), all revolving at 250 turns per minute, has brought the cost per H.P. installation below any H.P. cost hitherto achieved for similar work.

Following out your instructions at the beginning of the enterprise, it is and has been the purpose of the Engineering Department to produce a result that is: First, the best that can be made, and second, the most economical, wherein the word economy is used with special reference to economy in operation and fixed charge accounts.

Cost of Maintenance and Upkeep.

The practical operation of a plant designed upon the foregoing lines can have but one possible result, and that is the securing of an operation and upkeep expense gratifyingly low. The features of the design we believe call for the largest practical range of automatic handling of the different devices involved in the creation of the output. The structures are to be absolutely fire-proof throughout, and the masonry and steel materials entering into their buildings inhibit the contemplation of anything but the smallest maintenance account. The arrangement providing for the putting out of 125,000 H. P. from ten machines reduces the operating staff to a minimum not hitherto provided for in power plant construction.

Yours very truly,

HUGH L. COOPER,
Chief Hydraulic Engineer

RESIDENT ENGINEER'S REPORT.

MR. FREDERIC NICHOLLS, Vice-President and General Manager,
Electrical Development Company of Ontario, Limited, Toronto, Ont.

My dear Sir, —Pursuant to your instructions, I beg to submit the following report upon the work done, under the supervision of the engineering staff of the Electrical Development Company of Ontario, Limited, for the year ending December 31st, 1903.

Ground was broken in Victoria Park on February 25th for an office building for the Resident Engineer and staff and the structure was ready for occupancy by June 1st. The beginning of the actual construction on the power development may be said to date from April 2nd, when the first timbers for the crib coffer dam were laid down in the Niagara River. The duration of the construction work covered by this report would, therefore, embrace the interval between April 2nd and December 31st, or nine months.

During this period two important features of the scheme of development, upon which some reasonable doubt may have existed as to their practicability, have been proved to be feasible, namely, the construction of a coffer dam in the rapids of the Niagara River above Tempest Point, and the opening of a tunnel portal in the bluff under the heavy sheet of water of the Horseshoe Falls. The successful accomplishment of both these features may be said to have set at rest any doubt as to the entire practicability of the hydraulic development, as originally planned.

In general the scheme of development contemplates a deep wheel pit above the falls, connecting with a tail race tunnel emptying into the gorge below, a gathering dam extending into the river, to equalize the level of the water at the wheel pit, and head gates for the proper control of the water entering the pen-stocks.

On plate No. I is shown the location of the wheel pit and tail race tunnel, and the location of the temporary crib coffer dam, for the diversion of the water during the construction of the gathering dam and head gates.

Contracts have been entered into for the construction of the crib coffer dam, wheel pit and tail race branch tunnels and the main tail race tunnel. Studies and preliminary designs have been made for the gathering dam and head gates, but the final design cannot be completed until the fore-bay has been unwatered and the contour of the rock surface determined.

CRIB COFFER DAM.

The contract for the Crib Coffer Dam was awarded to Barry & McMordie, of Niagara Falls Ont., on March 14th, 1903.

Active work was begun on April 2nd, and to December 31st, the amount of work accomplished under the contract was as follows: -

2,258,568 ft. B.M. timber in place.
15,416 cu. yds. rock filling measured in place in the crib.
2,520 cu. yds. effective puddle in place.
1,470 cwt. iron work in place.

The general plan of location of the Coffer Dam is shown on Plate No. II. The progres of the work from month to month is indicated and several cross-sections given of the structure as actually built, on Plates No. III. and IV.

The crib work was started from the original shore line, four hundred and fifteen (415) feet above the upper end of the wheel pit. For the first four hundred and sixteen (416) feet the construction was comparatively simple, the cribs being built in place. The flow had been largely diverted from this portion of the river bed, by the Coffer Dam of the Ontario Power Company completed in December, 1902, and the small amount of water intercepted on this stretch was allowed to flow through culverts left in the crib work near the shore end. Between the second and third angles of the crib a heavy flow was intercepted, the water becoming deeper and the flow more rapid. The cribs were then built in the river, upstream from the Coffer Dam, and by means of cables from the shore were floated into place with the current.

It was found that the extension of the crib into the river, beyond the second angle, was causing a backing up of the water and to prevent a flooding of a portion of the fore bay, unwatered by the Ontario Power Company, a spur crib was constructed from this angle, leading upstream along the edge of the heavy flow. This spur was extended as occasion demanded, and ultimately reached an intersection with the protective works of the Ontario Power Company.

An agreement, for the building of the spur extension, was entered into with Barry & McMordie on June 17th, 1903, and to December 31st the following amount of work had been done:—

117,700 ft. B. M. timber in place.

707 cu. yds. rock filling measured in place in the crib.

211 cu. yds. effective puddle in place.

45 cwt. iron work in place.

At a point five hundred and seventy-six (576) feet from the shore, measured along the face of the crib, a decided fall in the elevation of the river bed was encountered. In three crib lengths (48 feet), the river bed dropped from elevation 522 to elevation 515, giving a depth of water of twenty-four (24) feet. This deep channel continued for about fifty (50) feet and then gradually shoaled to a depth of nineteen (19) feet, which depth was generally maintained until the cascade was reached.

Because of this great depth of water, the width of the crib work was increased to twenty four (24) feet. The puddle space was also increased in width and re-inforced by additional crib work, as shown on accompanying plates.

The placing of the cribs in this deep water, flowing at right angles to the end of the crib and at a high velocity, was an operation of very great difficulty. In order to break the force of the current, a fender was constructed of heavy timber, which rested against the upstream side of the crib-work and was projected beyond the last crib in place. The fender was held in position by three steel cables passing along the upstream face to the spur, where a winch was established to control the lines used in paying it out.

The cribs were framed in the slack water below the Coffer Dam and brought into position in the lee of the fender by means of stout tackle, operated from a travelling derrick at the end of the crib-work.

This travelling derrick was also of great service in the rapid handling of the heavy timbers used in framing the cribs.

On June 9th, at a distance of six hundred and ninety (690) feet from the shore, the strain on the fender was so great, from the impact of water, that the cross-bracing, to which the cables were attached, parted and the fender was carried away, passing out over the cascade and grounding about one hundred and fifty (150) feet off shore opposite Tempest Point.

A new fender of heavier design was constructed, which served its purpose until the cascade was reached. In attempting to move the fender over the cascade, it was broken to pieces by the force of the water and ultimately carried away. At this point, however, the crib-work was running nearly parallel to the heavy flow and no great difficulty was experienced from there on in placing the cribs without its assistance.

The original plans for the Coffer Dam were prepared on the basis of a probable depth of water of eight (8) feet. The depth of the water actually found has averaged over thirteen (13) feet. This increase in the depth necessitated the building of a structure much heavier in design than contemplated, and, in consequence, a material increase in the cost above that of the original estimate. The increase in cost will, in a very large measure, be balanced by the saving in the cost of deepening the fore bay and a bountiful supply of water is assured, with a small expenditure for excavation.

A start was made October 28th, placing clay in the puddle space. An excellent quality of clay was obtained from the south bank of the river, east of the Park boundary. The clay is transported over the Niagara Falls Park and River Railroad, and by means of a switch leading out on the Coffer Dam, is deposited from the cars into the clay space with a small amount of handling.

While the building of the Coffer Dam has been a work of considerable hazard, it has been singularly free from serious accidents. On October 5th occurred the first serious accident, which, unfortunately, resulted fatally. One of the timbermen, employed on the advance work, lost his footing and fell into the river, on the instream side of the Coffer Dam. The river currents at that point were not strong, but being unable to swim he was carried out before assistance could be given and his body washed over the falls. Another accident occurred on November 11th, which, while serious in its nature, resulted in no bodily harm. One of the divers employed in closing openings in the sheeting of the clay space, was drawn by the suction of the water against an opening, in which his foot and leg were caught and held by the force of the water. He remained in this position for over three hours before he was liberated from the perilous situation.

To December 31st one thousand seven hundred and ninety-four (1794) feet of main coffer dam has been placed, which has been re-enforced for a distance of one thousand two hundred and ninety-six (1,296) feet, with additional crib-work varying in thickness from sixteen (16) to eight (8) feet. To complete the work to an intersection with the shore below the wheel pit will require three hundred and forty-three (343) feet of additional crib-work, and this should be finished by about February next.

TAIL RACE TUNNEL.

The contract for the Tail Race Tunnel was awarded to Anthony C. Douglass, of Niagara Falls, N.Y., on May 14th, 1903.

As the Tail Race Tunnel lies under the river bed for its entire length, provision was made in the contract for a construction shaft to be sunk on the west shore of the river above the Falls, and a small working tunnel or drift to be driven under the river out to the Tail Race Tunnel, the excavated material to be disposed of either by hoisting vertically through the shaft, and wasting over the bluff, or by dumping under the Falls through openings from the drift to the cliff back of the curtain of water.

The excavation of the Tail Race Tunnel will proceed from the Falls up grade to the wheel pit, in the most favorable manner for drainage, should water be encountered. Provision was also made for a shaft at the upper end, should it be required for the purpose of expediting the work of construction.

The location of the construction shaft, drift, and Tail Race Tunnel is shown on the general plan, Plate No. I. The drift was planned so as to intersect the Tail Race Tunnel at a point about one hundred (100) feet from the Portal, and will have a length of six hundred and seventy and nine-tenths (670·9) feet, measured from the shaft. The length of the Tail Race Tunnel, from the cliff under the Falls to the branch tunnels at the wheel pit, will be nineteen hundred and thirty-five (1935) feet.

Cross-sections of the Tail Race Tunnel are shown on Plate No. V. As the roof will lie entirely in the shale, it will require during its construction a temporary timber lining. For a distance of three hundred (300) feet from the face of the cliff, the tunnel will have a permanent lining of concrete, divided by vertical joints into rings six (6) feet in length, in order that, as the Falls recede these rings will break away as a whole, leaving a finished surface at the new end of the tunnel. For the balance of the distance, the tunnel will have a permanent lining of two rings of hydraulic pressed brick backed solid to the rock with concrete.

A light steel gallery, for inspection purposes, will be suspended from the roof of the tunnel and be lighted by electricity. By means of this gallery access may be had to the tunnel at all times, even while the plant is in operation.

Work on the construction shaft was begun on May 18th, 1903. For a depth of sixteen and one half (16½) feet the shaft penetrated loose material, which admitted water from the river very freely. A pit, approximately forty-six (46) feet by thirty-nine (39) feet, was excavated in the loose material and carried to a depth of two (2) feet below the level of the water in the river. In the excavation a coffer dam was constructed, surrounding the mouth of the shaft. Because of the very open nature of the material upon which the coffer dam rested, considerable trouble was experienced from the inflow of water, and it was not until June 25th that the excavation reached the original rock surface. The seamy surface rock was removed for a depth of four (4) feet to an impervious stratum of limestone, and the final shaft timbering placed and surrounded by a wall of Portland cement beton, which effectually cut off the water entering the shaft.

From this point to sub-grade rapid progress was made, and sub-grade reached at a depth of one hundred and fifty and two-tenths (150.2) feet on August 28th. During August the shaft was sunk through a depth of one hundred and one and one-half (101.5) feet, and in addition fifteen (15) feet of the drift was excavated. This progress in shaft sinking is remarkable, and as far as can be learned has never been equalled for speed.

The extent and character of the materials penetrated by the [illegible] is shown on Plate No. VI. The dimensions of the shaft are fifteen (15) feet long by [illegible]) feet wide, in clear of all timbering.

Except through the loose material near the surface, no shaft timbering was required during the construction. The shale rock, however, has a tendency to disintegrate slowly on exposure to the air, and the lower portion of the shaft, which passes through the shale formation, will ultimately be timbered.

The dimensions of the drift are, approximately, fourteen (14) feet in width by seven (7) feet high, an area sufficient for two construction tracks. The drift leaves the shaft at elevation 366 and, with a slight fall in grade, will intersect the Tail Race Tunnel at about spring line or twenty-three (23) feet above normal high water in the gorge.

During September the drift was excavated a distance of three hundred and one and one-half (301.5) feet, and on October 7th, at a distance of three hundred and eighty-five (385) feet from the shaft, the cross-drift, leading out to the cliff under the Falls, was begun.

Up to this time the drift had been very dry, and the small amount of water entering the shaft was easily controlled by a No. 5 Cameron Mining Pump, working only at intervals. On October 9th, when within an estimated distance of fourteen (14) feet from the cliff, a fissure was developed in the roof, by a round of holes fired in the cross-drift, through which water came in considerable volume, flooding the drift and causing a suspension of work. Pumps, of a capacity sufficient to handle the flow, were at once installed and the water lowered so that a resumption of work was possible. Preparations for drilling were under way when a fall of rock occurred near the face of the cross-drift, and a large increase in the flow took place, again flooding the drift.

It was found that the water rose in the shaft to a height of sixteen (16) feet above the grade of the drift, before finding its level, thus indicating that the water came from the heavy spray under the Falls, striking the cliff, and finding its way through fissures, whose openings were, approximately, at this elevation. This inference was completely borne out by subsequent events.

A heavier pumping plant was installed, and on October 28th the water was lowered and work resumed in the cross-drift. Holes were drilled in the face, varying in length from eighteen (18) to twenty-two (22) feet, indicating a barrier of solid rock of about twelve (12) feet in thickness, and beyond this a softer rock somewhat disintegrated, but of unknown thickness, none of the holes penetrating to the face of the cliff. In all, eighteen holes were drilled, and as the flow into the drift was increasing in volume and gaining on the pumps, it was decided to load the holes and blast away the barrier. In addition to the dynamite used in the holes, ten cases of sixty per cent. dynamite were placed at the face of the cross-drift, and the drift was allowed to flood before firing.

The blast broke down the solid rock barrier and opened a thorough cut through the disintegrated rock and talus, out to the sheet of water, and down to an elevation about twelve inches below the drift roof.

The water in the drift fell to this level, and several efforts were made to reach the opening, by means of a boat through the drift, in order to blast away the remaining barrier and allow the water to flow out. A trip made in this manner, by several of the miners, is accurately described in the Toronto *News* of November 3rd, 1903.

Failing in this attempt, two of the foreman successfully made the trip around behind the Falls, to the mouth of the drift. Starting from the Scenic Tunnel, these men, roped together, crept along the top of the talus to the mouth of the drift, four hundred and fifty (450) feet from the Canadian side of the Falls, and demonstrated the feasibility, though not unattended with danger, of a passage over the talus.

A number of trips were made in this way and a large amount of dynamite was carried out back of the Falls and used in open blasts, to scatter the talus and loose rock obstructing the mouth of the drift. By this means a trench was made down to grade, through which the water flowed out, and complete drainage was established and the pumps removed.

The trench in the talus was widened, and a timber shield constructed out from the opening to within about twelve (12) feet of the curtain of water, to protect the men from the heavy spray. The construction of this shield, which was built of 12" x 12" yellow pine timbers, was a most difficult and trying operation. The men working under the heavy fall of spray, which came in gusts of such fierceness and strength as to sweep them frequently from their feet, were roped to the heavy timbers, which in several instances saved them from being swept under the falls.

From the end of this shield a chute was constructed, for the disposal of the excavated rock, and when work was resumed on the drift extension on November 20th, the material excavated was disposed of through the chute and carried away under the Falls by the force of the spray.

On Plate No. VI. is shown a sketch of the conditions found to exist at the mouth of the drift. The talus is held in place by the compact limestone formation, which extends well out to the sheet of water. The atmospheric conditions are normal, and the entire practicability of discharging the tail water from the wheel pit, under the Falls is beyond question.

The following work has been accomplished under this contract to December 31st :

158 linear feet of Construction Shaft Excavation.
741.4 " " " Drift "
11 " " Tail Race Tunnel Excavation.

Only one serious accident has occurred on this work. It was found that some disintegration had occurred in the shale rock of the shaft, due to the exhaust steam from the pumps. During the removal of the loose rock, on October 15th., the shaft foreman went below this danger zone to oil the pumps, when a piece of rock, falling from a height of about twenty (20) feet, struck him on the back, dislocating his spine. He was taken to the hospital and subsequently died of the injuries received.

The plant assembled and in use, for the prosecution of the contract, is as follows :

2—20¼ x 14 x 12¼ x 14 Compound Duplex Air Compressors.
1—400 H. P., 3 Phase, 2240 Volt Motor.
2—25 H. P. Locomotive Boilers.
1—8 x 12 Double Drum Hoisting Engine.
10—3¼ Ingersoll Sargeant Drills, complete.
1—Blacksmith Shop, complete, with tools.
3—No. 9 Plunger Pumps.
1—No. 5 Plunger Pump.
1—16 x 10½ x 16 Piston Pump.
1—7½ x 5 x 6 Duplex Pump.

The compressors are operated by electric power from the Niagara Falls Power Company

WHEEL PIT.

The contract for the Wheel Pit and tail race branch tunnels was awarded to M. P. Davis of Ottawa on July 21st, 1903.

Work was begun on August 10th, grading for a siding, from the Park and River Railway to the Wheel Pit site, to facilitate the delivery and handling of machinery and supplies.

On Plate No. VII. is shown, in plan and elevation, the general features of the Wheel Pit and branch tunnels.

On Plate No. VIII. is shown sections of the Wheel Pit and Branch Tunnels.

The Wheel Pit is designed for an installation of eleven turbine wheels, each of 12,500 H.P. capacity.

The tail race tunnel branches at a point one hundred and sixty-five (165) feet from the lower end of the Wheel Pit, into two lateral tunnels, which pass on either side of the Wheel Pit. The intervening rock is pierced at intervals by draught tubes, which enter the lateral tunnels through the invert. A water seal is thus preserved at all stages of operation. Single draught tubes are used, each alternate wheel discharging into the same tunnel, six draught tubes entering the north tunnel and five the south.

Gate chambers are provided for each side tunnel, so that it is possible, by closing the gate in either tunnel and shutting down the wheels discharging into this branch, to make an inspection while the other half station is in operation.

The turbines will rest on a rock foundation, which is a distinct advantage in operation, where vibration has to be considered.

Heavy concrete arches will be thrown across the pit at intervals, as shown on Plate No. VIII. These arches will form the supports for the thrust bearings and, in addition, will prevent any lateral movement of the rock strata.

The branch tunnels are connected by a passage-way, leading from the Wheel Pit, and by means of the steel gallery in the tail race tunnel, previously mentioned, will give access to all parts of the plant during operation. It will be possible for one entering at the Wheel Pit to traverse the length of the tunnel to the portal under the Falls.

A chamber will be excavated at the level of the turbine deck for the oil pumps and other auxiliary machinery.

As the site of the Wheel Pit had not been unwatered by the crib coffer dam, under construction by Barry & McMordie, at the time of the awarding of this contract, provision was made for the construction of an inner coffer dam, by the Wheel Pit contractor, surrounding his work, within a minimum clearance of thirty-five (35) feet from the head gates.

Work on this Coffer Dam was begun on September 2nd, and its location is shown on Plate No. II. It consists of a double line of crib-work with a clay space between. The outer crib varies in thickness from seven (7) to twelve (12) feet, depending on the depth of water encountered. At the lower end a maximun depth of fifteen (15) feet of water was recorded. The inner crib has a uniform width of seven (7) feet and was carried to the level of the water in the river, and above this stout timber bracing was used to hold the sheeting for the clay space. The clay space was sheeted with two thicknesses of one inch plank, breaking joint and carefully scribed so as to fit accurately the river bed. The foundation for the cribs was found to be very irregular, large boulders and detached masses of ledge covering the rock surface, which was also badly fissured.

The coffer dam was completed on November 7th, and an attempt made to drain the enclosed fore bay by means of pumps, but, because of the heavy percolation through seams in the bed rock, it was not until December 1st that the water was lowered, so as to expose practically the whole area enclosed by the coffer dam.

While the amount of excavation has been small, because of trouble in unwatering the site of the Wheel Pit, yet extensive preparations for the rapid handling of the work are being made by the establishment of a large plant and the erection of a timber shed over the entire Wheel Pit, thereby enabling the contractor to be independent of weather conditions at all seasons.

The air compressor will be operated by electric power obtained from the Niagara Falls Power Company, and a transmission line has been constructed for this purpose from the transformers at the International Railway's Power House, in Victoria Park, to the Wheel Pit site.

The following heavy plant, for the prosecution of this work, has been installed, or is in process of installation:

2 Rand two-stage belt-driven Compressors of 1200 cubic feet each of free air per minute, with intercoolers and air receivers.
4 100 H.P. Induction Motors, with switch panels and auto-transformers.
2 Compound Generators, D.C., 12½ K.W., with switchboard, volt meters and ammeters.
2 4-Drum D.C., 8¼″ x 10,″ Skeleton Hoisting Engines.
2 2-Drum D.C., 7″ x 12,″ " "
2 2-Drum D.C., 7″ x 12,″ Hoisting Engines, with Boilers.
2 2-Drum D.C., 8″ x 12″ " "
1 1-Drum S.C., 6″ x 8,″ Skeleton Hoisting Engine.
7 6-Ton Stiff-leg Derricks.
1 12-Ton " "
1 12-Ton Guy Derricks.
2 Duplex Steam Pumps, 6″ x 4″ x 6″.
1 " " 10″ x 6″ x 10″.
1 Duplex Compound Pump, 18″ x 12″ x 10″ x 10″.
1 Duplex Pump, 18″ x 10″ x 12″.
1 Direct Connected 6″ Centrifugal Pump.
2 " 8″ "
1 " 20″ "
2 No. 7 Pulsometers.
2 100 H.P. Boilers.
1 75 H.P. Boiler.
1 500 H.P. Feed Water-heater.
31 3¼″ Rand Drills.
17 4″ x 9′ Quarry Bars.
1 12″ x 12″ High-speed Horizontal Engine.
1 5′ x 5′ Concrete Mixer.
1 No. 5 Rotary Stone Crusher, with Elevator and Screens.
1 500 H.P. Electric Transmission Line, 3,700 feet long.
1 Office Building, 16′ x 40′.
1 Store House, 30′ x 50′.
1 Power House and Machine Shop, 35′ x 65′. (Machine shop equipped with tools).
1 Shelter House, 48′ x 425′.
1 Blacksmith Shop, 24′ x 30′.

Engineering Staff.

The following is a list of the members of the Engineering Staff at Niagara Falls, Ontario: -

Julian Thornley	Senior Assistant Engineer	Appointed	Feb. 15, 1903.
Henry P. Rust	Transitman	"	May 4 1903.
Carlton W. Allen	Rodman	"	June 1, 1903.
Oscar de W. Randolph	"	"	June 27, 1903.
Newman W. C. Hoyles	"	"	July 13, 1903.
Wm. G. Cameron	Guage Recorder	"	Mar. 10, 1903.
George A. McPherson	Cement Tester	"	Sept. 1, 1903.
May Quillinan	Stenographer	"	May 1, 1903.
Thomas Barnett	Inspector	Employed	Feb. 19. 1903, to date.
Charles Willox	"	"	Feb. 20, 1903, to date.
James McDonald	Axeman	"	Feb. 20, 1903, to Mar. 20, '03.
Alexander D. Henderson	"	"	Feb. 20, 1903, to June 1, '03.

Mr. Randolph resigned on September 3rd, 1903.

A base line has been laid out in the park and monumented, and a system of triangulation established for the tunnel alignment.

The fluctuations of the River have been recorded, by means of guages placed, at various points.

A Cement Testing Laboratory has been established at the Resident Engineer's Office, and a series of tests are being conducted on various brands of Portland cement.

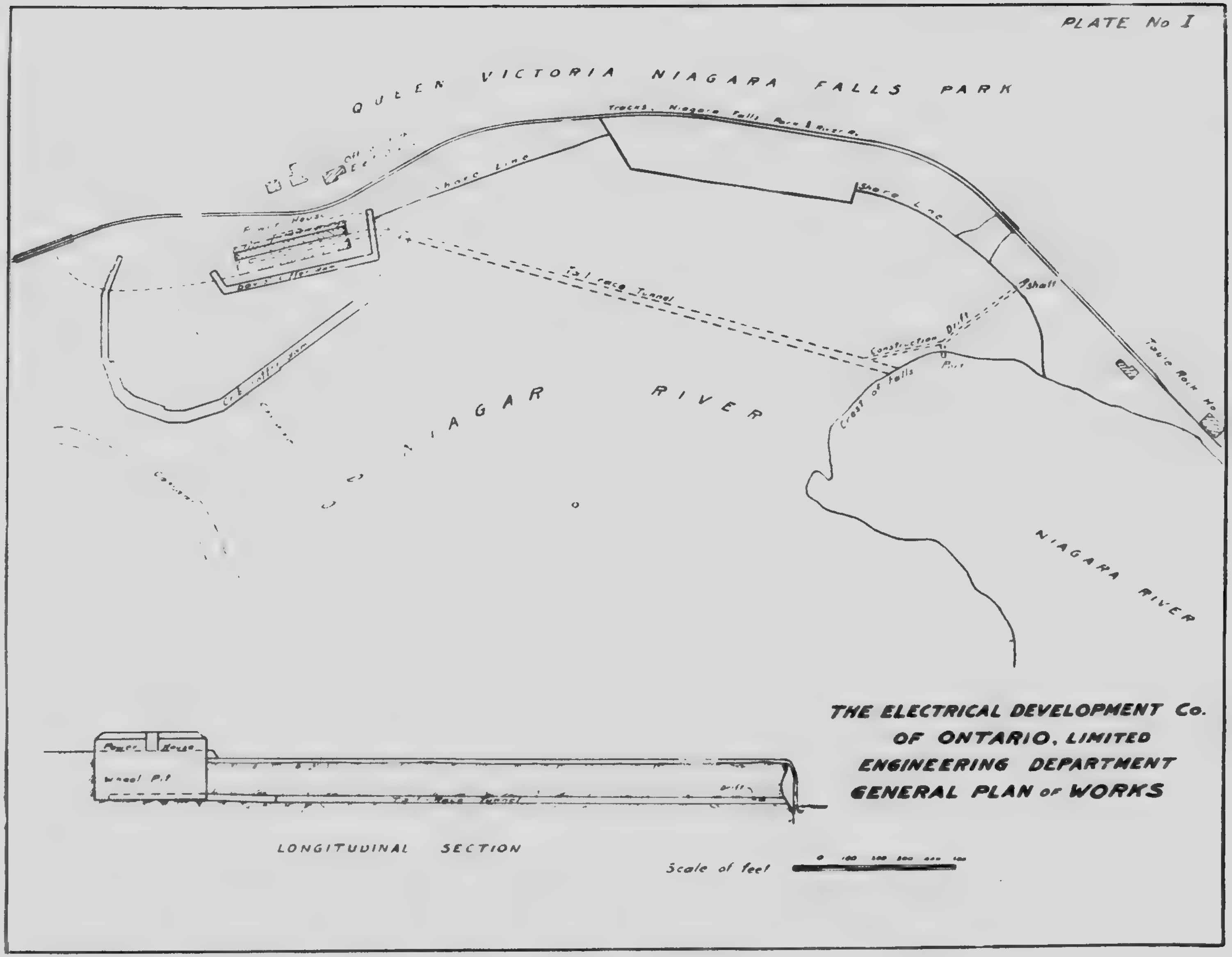
Tests of brick, sand, and other materials, used in the construction work, are also being made.

In conclusion, the Resident Engineer desires to express his appreciation of the faithful and efficient services rendered by the members of the engineering staff, also to the contractors for their earnest co-operation in the furtherance of the work.

Respectfully submitted,

BEVERLEY R. VALUE.
Resident Engineer.

PLATE No I



THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
GENERAL PLAN OF WORKS

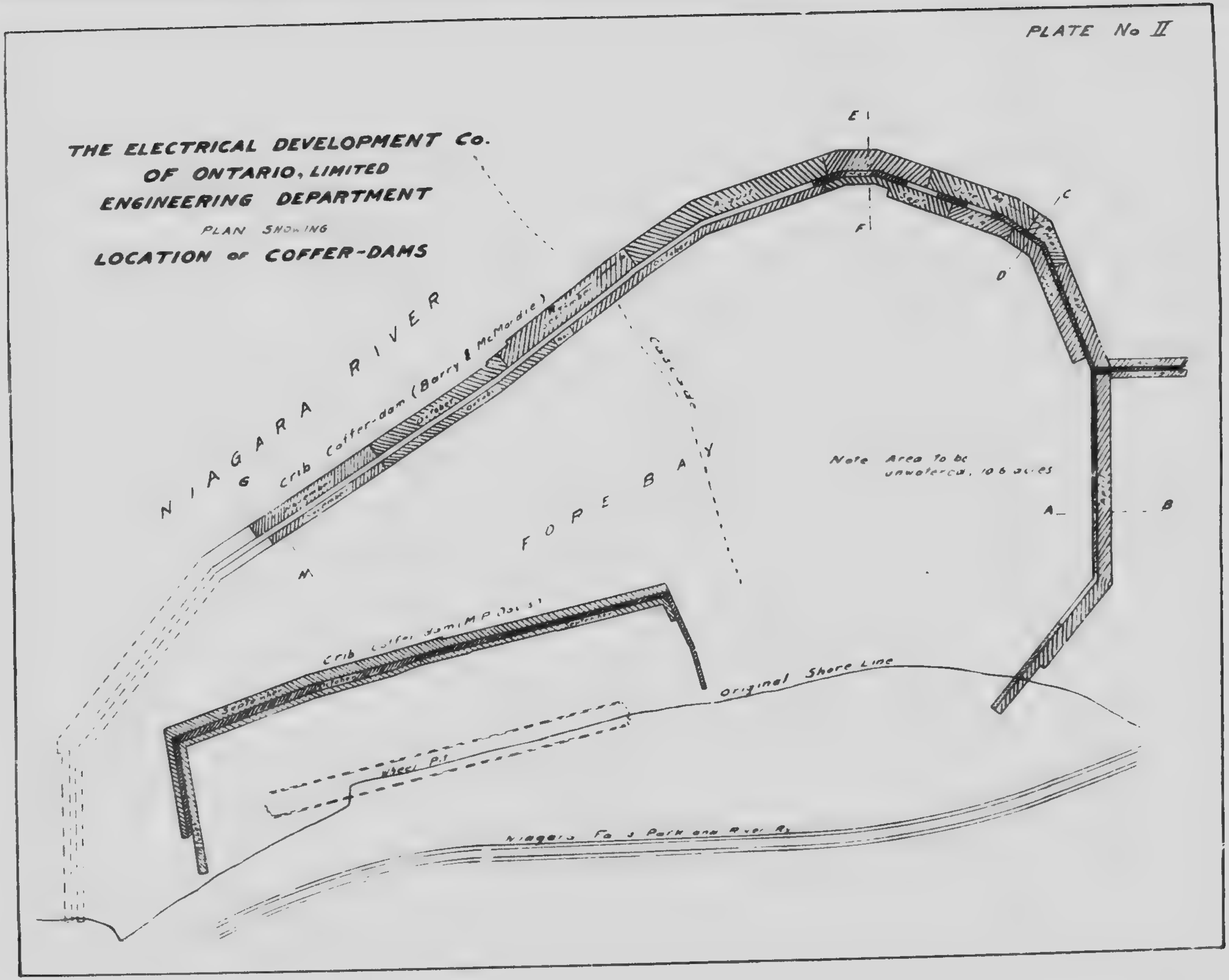
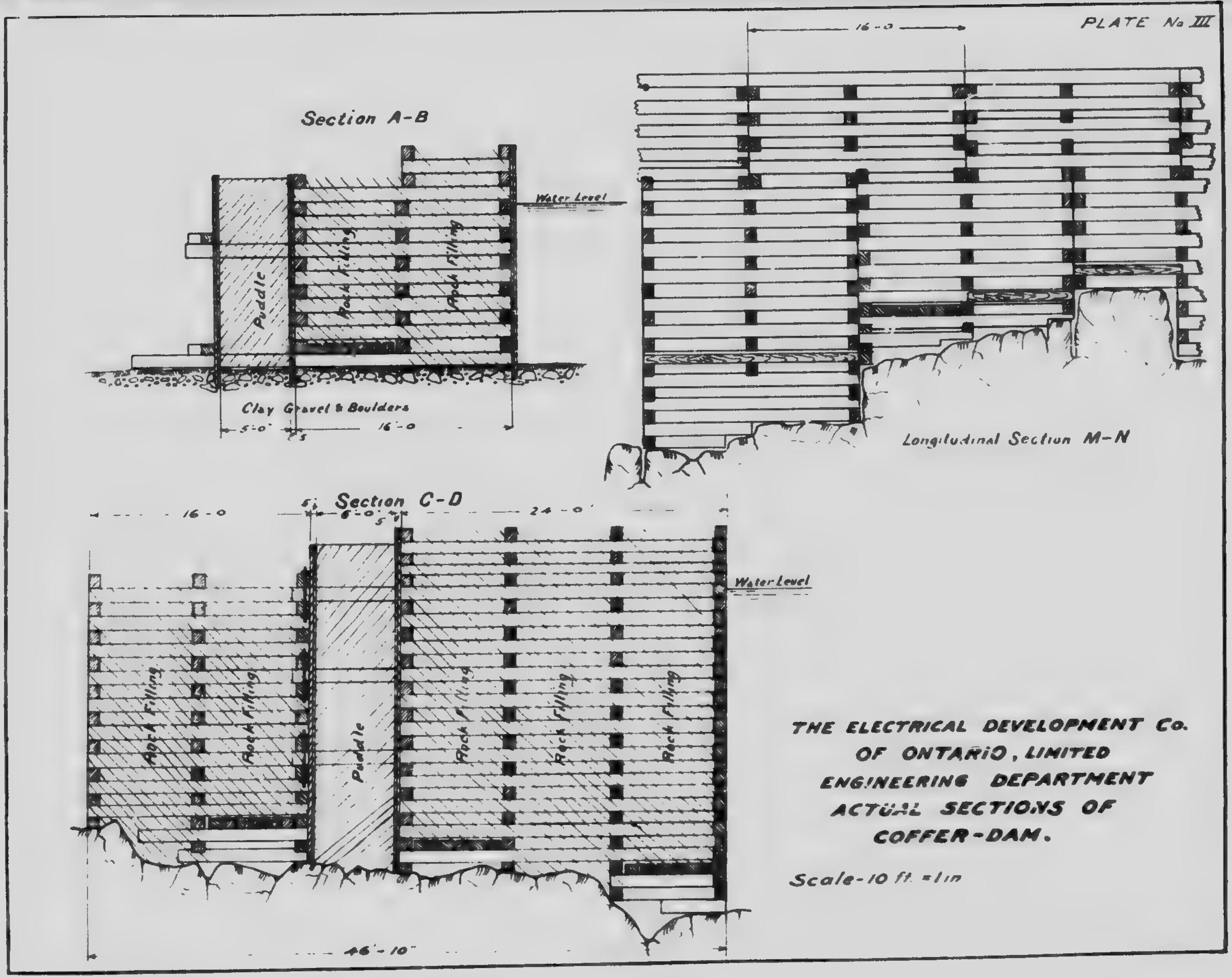
PLATE No II
THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
PLAN SHOWING
LOCATION OF COFFER-DAMS
NIAGARA RIVER
Crib Coffer-dam (Barry & McMordie)
FORE BAY
Cascade
Note Area to be unwatered, 10.6 acres
E
F
C
D
A
B
G
M
Crib Coffer-dam (M.P. Dou...)
Wheel Pit
Original Shore Line
Niagara Falls Park and River Ry

PLATE No. III



THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
ACTUAL SECTIONS OF
COFFER-DAM.

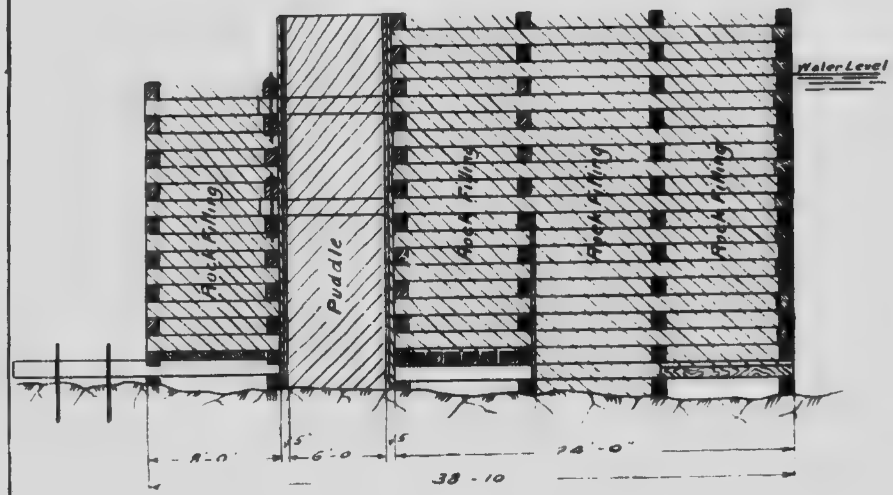
Scale-10 ft. = 1 in

PLATE No. IV

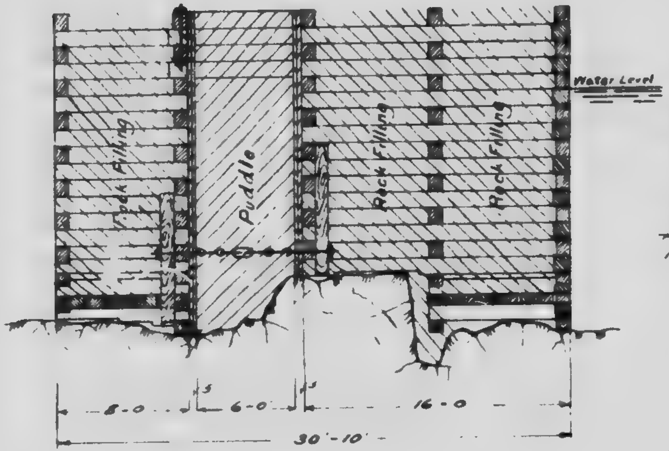
THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
ACTUAL SECTIONS OF
COFFER-DAM.

Scale - 10 ft=1 in

Section E-F



Section G-H



Longitud. al Section K-L

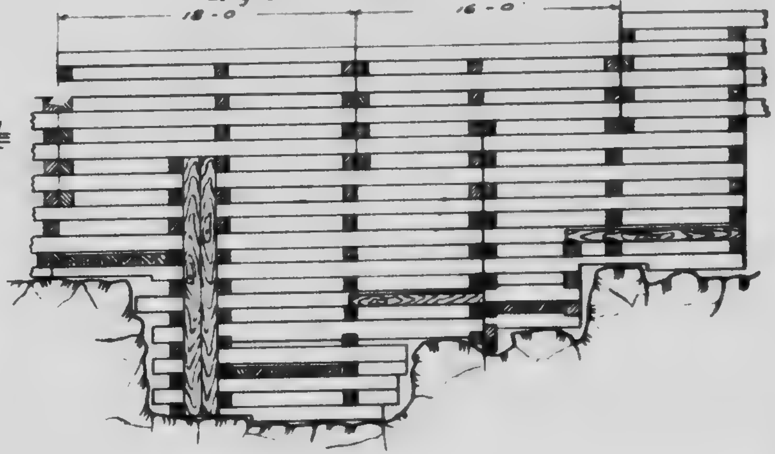
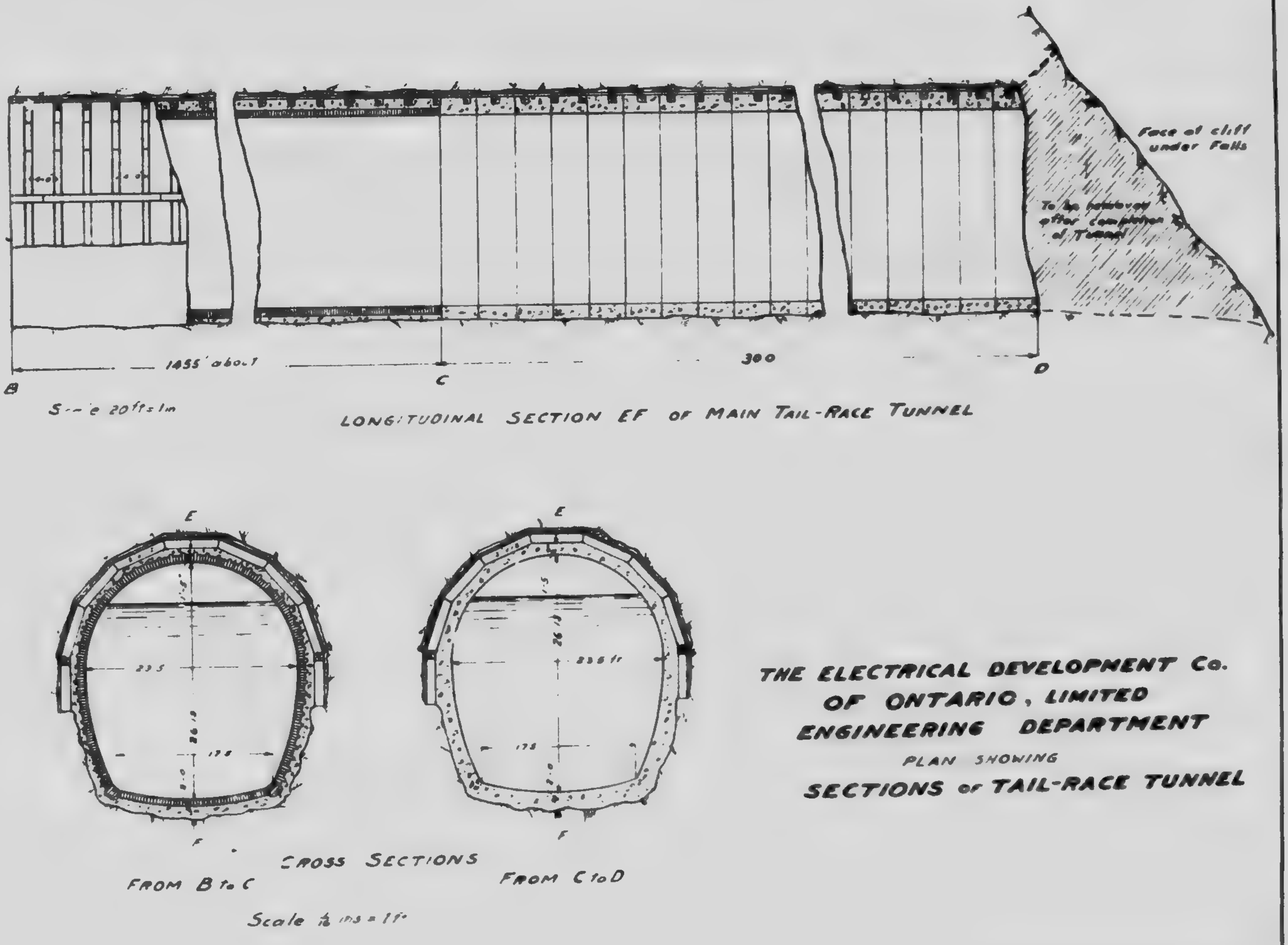


PLATE No V


Face of cliff under Falls
To be removed after completion of Tunnel
1455' about
300
B
C
D
Scale 20 ft = 1 in
LONGITUDINAL SECTION EF OF MAIN TAIL-RACE TUNNEL
E
F
23.5
17.5
23.5 ft
CROSS SECTIONS
FROM B to C
FROM C to D
Scale ½ ins = 1 ft

THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
PLAN SHOWING
SECTIONS OF TAIL-RACE TUNNEL

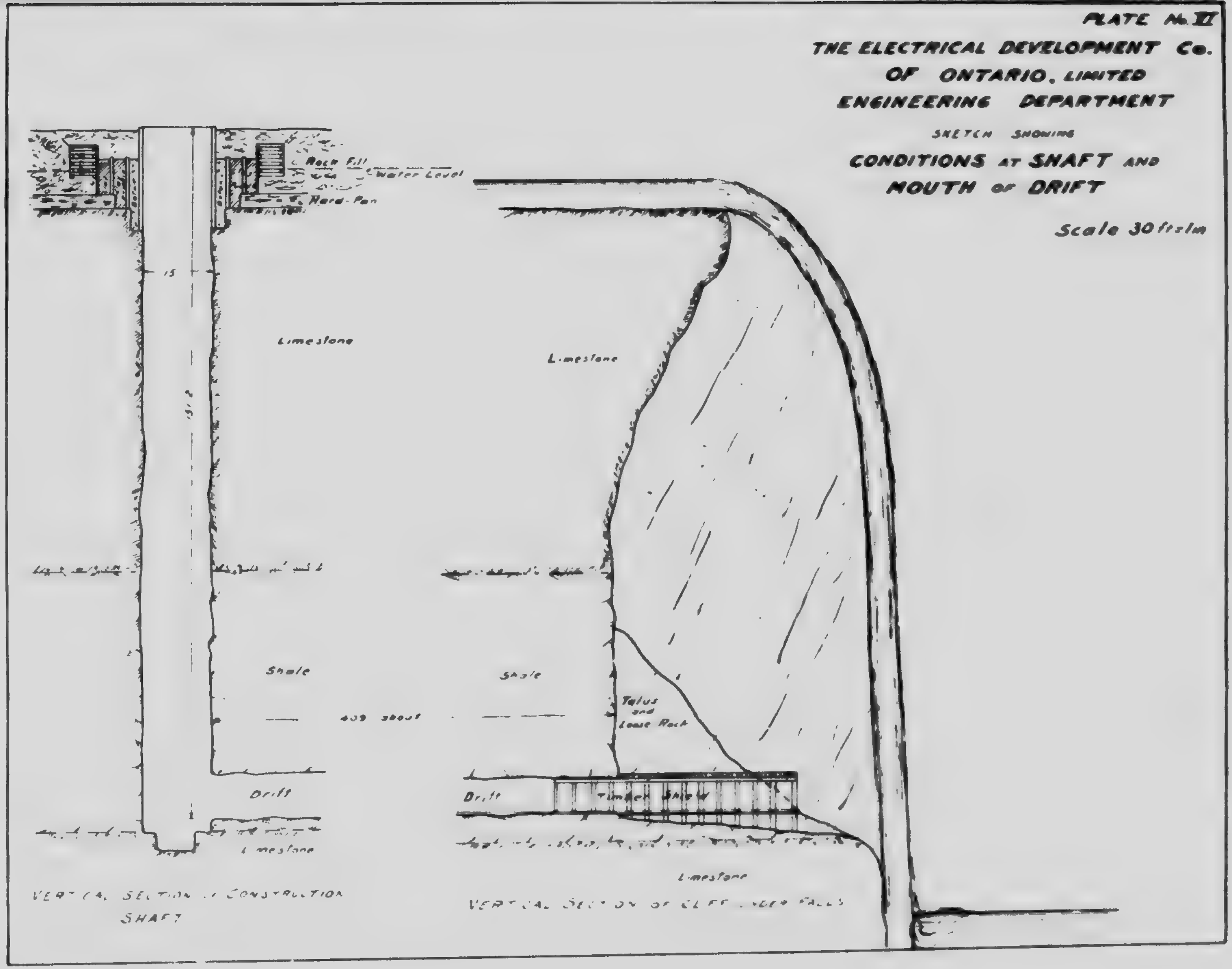


PLATE No. II

THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT

SKETCH SHOWING
CONDITIONS AT SHAFT AND
MOUTH OF DRIFT

Scale 30 ft = 1 in

PLATE No VII

THE ELECTRICAL DEVELOPMENT Co.
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT

PLAN SHOWING

WHEEL-PIT AND BRANCH
TAIL-RACE TUNNELS

Scale - 80 ft = 1 in

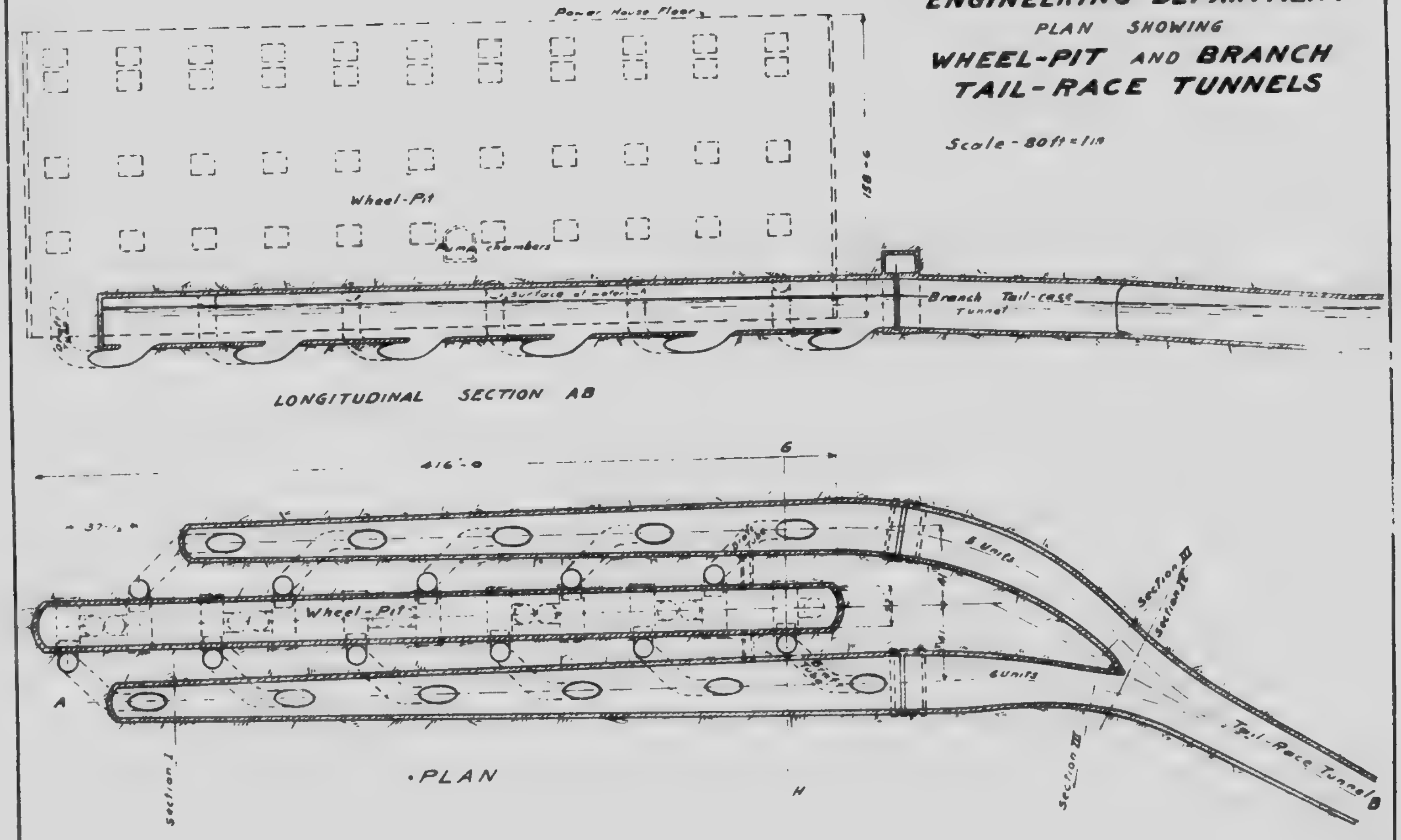
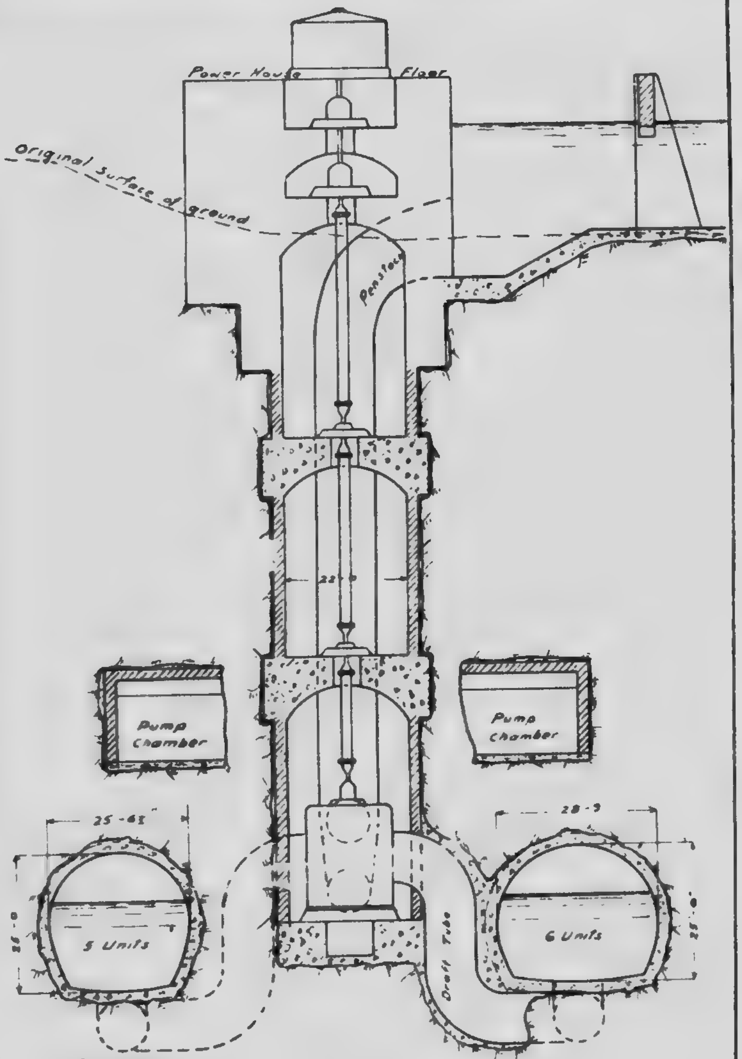


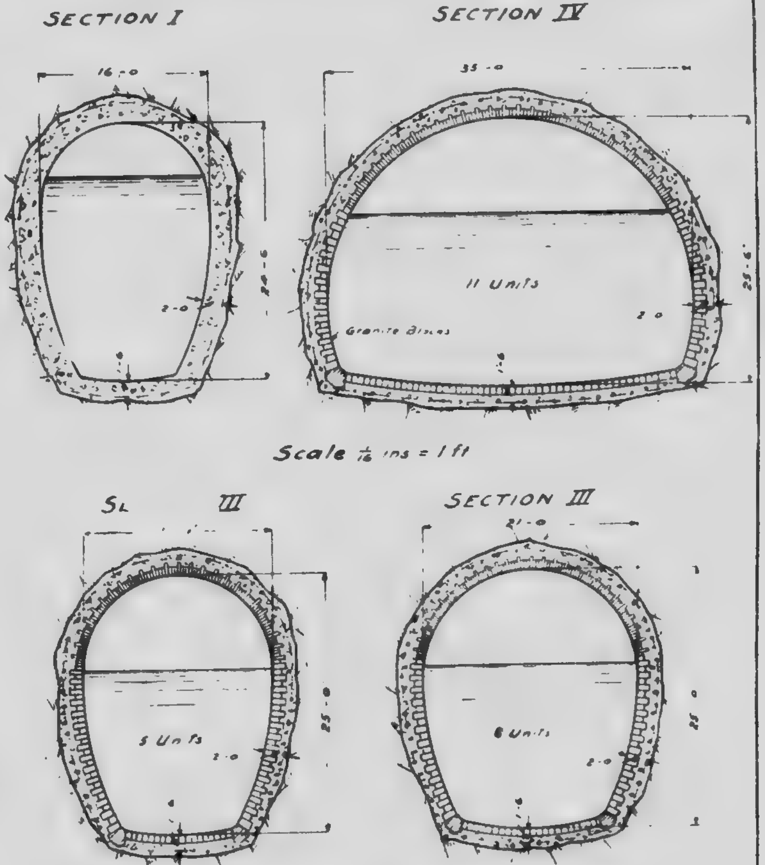
PLATE No VIII



Scale, 30 ft=1 in

Cross Section of Wheel-Pit and Branch Tail-Race Tunnels at 6H

Cross-Sections of Branch Tail-Race Tunnels



THE ELECTRICAL DEVELOPMENT Co
OF ONTARIO, LIMITED
ENGINEERING DEPARTMENT
PLAN SHOWING
SECTIONS OF PIT AND TUNNELS

REPORT OF CHIEF ENGINEER, RIGHT OF WAY.

Frederic Nicholls, Esq., Vice-President and General Manager,
The Toronto and Niagara Power Company, Toronto.

Sir,—I have the honor to report, in brief, that the location of the route for the Toronto and Niagara Power Company's Electrical Transmission Line, has been completed between the Electrical Development Company's Power Works, situated at Tempest Point in the Queen Victoria Park, Niagara Falls, and Scarlett Road, Lambton, on the north-western confines of the City of Toronto.

The total distance between the two points mentioned is 75½ miles.

The location has been selected with a view to the utilization of the right of way lands not only for electric power transmission lines but for railway purposes, and in this respect it may be noted that the country traversed does not present serious engineering difficulties.

The gradients toward Toronto need not exceed 15 feet per mile with moderate work, while in the opposite direction the only section on which that maximum will be exceeded lies between the eastern extremity of Burlington Beach and the top of the escarpment, near Grimsby, a distance of ten miles, where the gradient, in places, will reach one per cent.—or 52.8 feet per mile. This ascent is unavoidable as the difference between the level of Lake Ontario and that of Lake Erie, about 340 feet, has at least to be overcome. The gradients Torontowards are easier than on existing lines of railway.

The percentage of curved lines is small notwithstanding the mountain ascent, while the rate of curvature in no case exceeds 3½ degrees, or a radius of 1637 feet.

Considering the advantages which may thus be obtained for very rapid rail transit, by electric power, between the Niagara River frontier and Toronto, the small additional distance over air lines between fixed points, is inappreciable from an electrical transmission point of view, while for the railway of the future, with a train service rated at one hundred miles per hour or more, it is obvious that the best alignment and gradients the country can economically afford are necessary.

A private right of way has been largely secured through the districts traversed, on a minimum basis of 80 feet in width (with enlargements where necessary), to provide for pole transmission lines and for a double track railway, while where forest land is passed through, the right to cut down trees, etc., has been secured for such extra distances as may be advisable to ensure freedom from accident, interruption to electric transmission or to train service.

Tenders for fencing the entire right of way are invited, and the contract will be awarded at once, so that material may be secured in time for construction early in 1904.

I have the honor to remain, sir,

Yours truly,

Wm. T. JENNINGS, M.I.C.E.,

Consulting Engineer.

SOLICITOR'S REPORT.

Frederic Nicholls, Esq., Vice-President and General Manager.
The Electrical Development Company, and
The Toronto and Niagara Power Company.

Dear Sir,—I beg to report to you the Solicitor's work done by me for the Electrical Development Company and the Toronto and Niagara Power Company.

The Act of Incorporation of the Toronto and Niagara Power Company was obtained in May, 1902, from the Parliament of Canada, authorizing the generation and transmission of electrical power within the Province of Ontario, the work being declared to be for the general advantage of Canada; the capital stock authorized by the Act being $3,000,000 and the bond issue $1,500,000.

The bond issue under this Act was limited as above-mentioned to the amount of $1,500,000, and a much larger issue being required to meet the further developed plans of the directors, it was then too late to increase the bonding powers by amendment of that Act at the session of Parliament of 1902-1903, and as the time could not be spared until the following session, one year later, the directors authorized the issue of a provincial charter in the name of the Electrical Development Company of Ontario, Limited, and in February, 1903, a charter was accordingly obtained from the Ontario Government, issued pursuant to the Joint Stock Companies' Act, the share capital of the company being $6,000,000 with a legalized bond issue of $10,000,000.

In March, 1903, an agreement was entered into between Messrs. William Mackenzie, H. M. Pellatt and Frederic Nicholls, therein called the "Syndicate" and the Electrical Development Company, whereby the franchise, obtained by the syndicate from the commissioners of the Queen Victoria Niagara Falls Park and the Government of Ontario, dated 29th January, 1903, was transferred to the company upon the terms and for the considerations therein mentioned.

In February, 1903, an agreement for the transmission and supply of electrical power was made by the Toronto and Niagara Power Company with the Toronto Railway Company.

In February, 1903, an agreement for the transmission and supply of electrical power was made by the Toronto and Niagara Power Company with the Toronto Electric Light Company

Underwriting agreements for the bonds and stock of the company were prepared.

Bonds of the Electrical Development Company were authorized to the extent of $10,000,000 dated 1st March, 1903, the present issue being to the amount of $5,000,000, the balance remaining in the treasury of the company; the said issue was secured by a trust mortgage executed by the company to National Trusts Company of Ontario, as trustees The form of the bonds, and of the trust mortgage, were revised by Mr. Z. A. Lash, K.C acting as counsel for the Company.

Bonds of the Toronto and Niagara Power Comany were authorized to the extent of $1,500,000, dated 1st March, 1903, and such issue was secured by a trust mortgage executed by the Company to the National Trusts Company of Ontario, as trustees.

On the 7th March, 1903, the contract with Barry & McMordie for the construction of the coffer dam in the Niagara River was prepared and executed, and security taken from the contractors in the sum of $25,000.

On the 14th May, 1903, the contract for the construction of the tail race tunnel and construction shaft with Mr. A. C. Douglass was prepared and executed, and a surety bond of the Title Guaranty and Trust Company of Scranton, Pa., in the sum of \$200,000 was obtained from the contractor.

On the 21st July, 1903, the contract for the construction of the wheel pit with Mr. M. P. Davis, of Ottawa, was prepared and executed, and a surety bond of the United States Fidelity and Guaranty Company, in the sum of \$200,000, was obtained from the contractor.

The titles were searched and the purchase completed on the 12th October, 1903, of the Welland Farms property. This property, containing 530 acres, or thereabouts, was purchased by the Electrical Development Company for factory sites and other necessary purposes. It has a frontage upon the Welland River of over one and a half miles, and is situate three miles from the mouth of the river and about two miles from the town of Niagara Falls.

Since the month of July, 1903, the purchase of the right of way has been in progress, a full report of which has been submitted to the General Manager. The total number of acres to be bought, exclusive of sections where running rights may be obtained, or other arrangements made, is $716\frac{69}{100}$ acres, and agreements have already been made for the purchase of $475\frac{56}{100}$ acres.

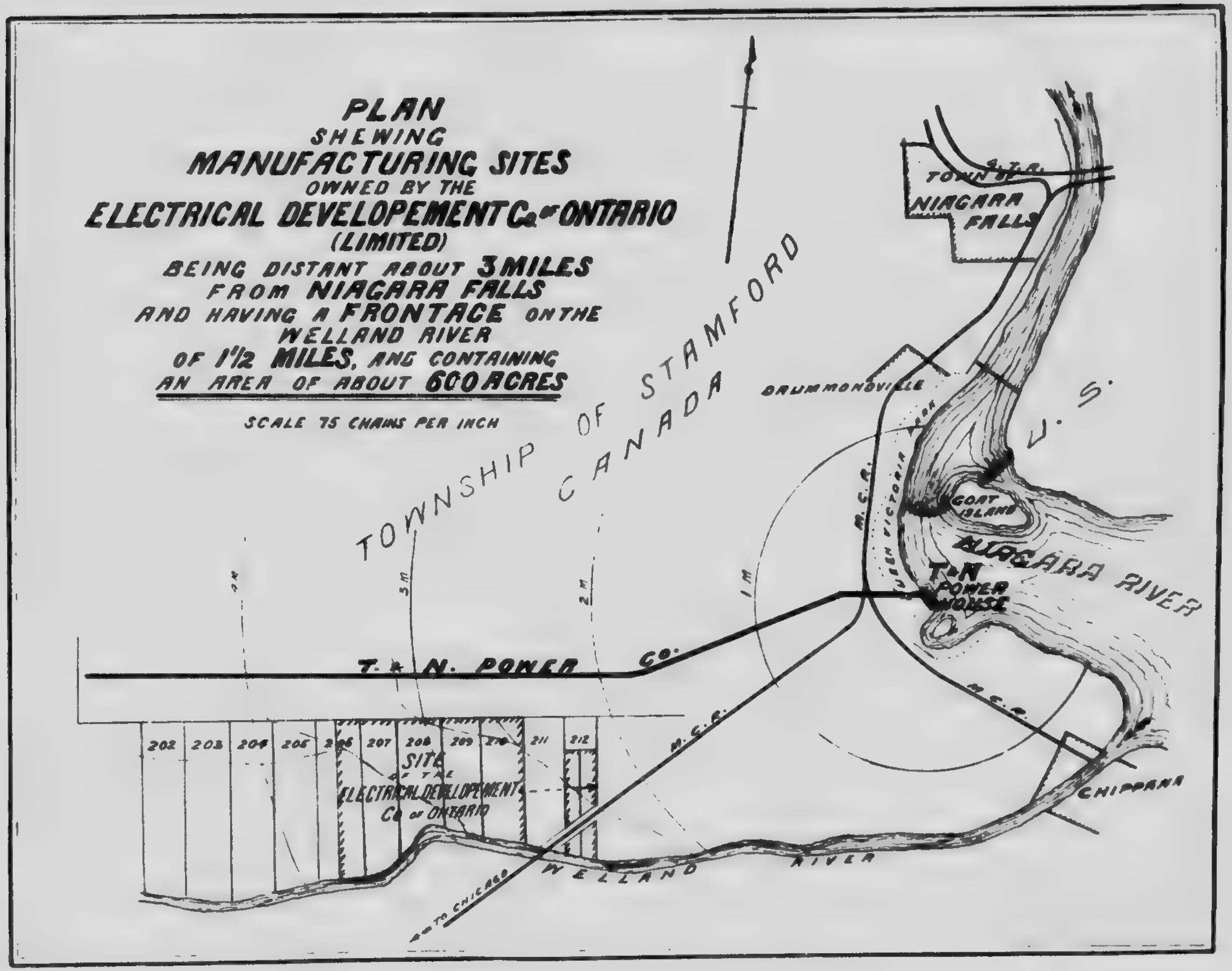
The titles to the properties purchased are being searched and passed and the purchase money paid over, and the purchases closed as rapidly as possible.

There is now being completed the purchase of fifty acres of land at Lambton from the Langmuir Syndicate and of nine acres adjoining from the Brock estate, which are intended for terminal purposes.

Yours truly,

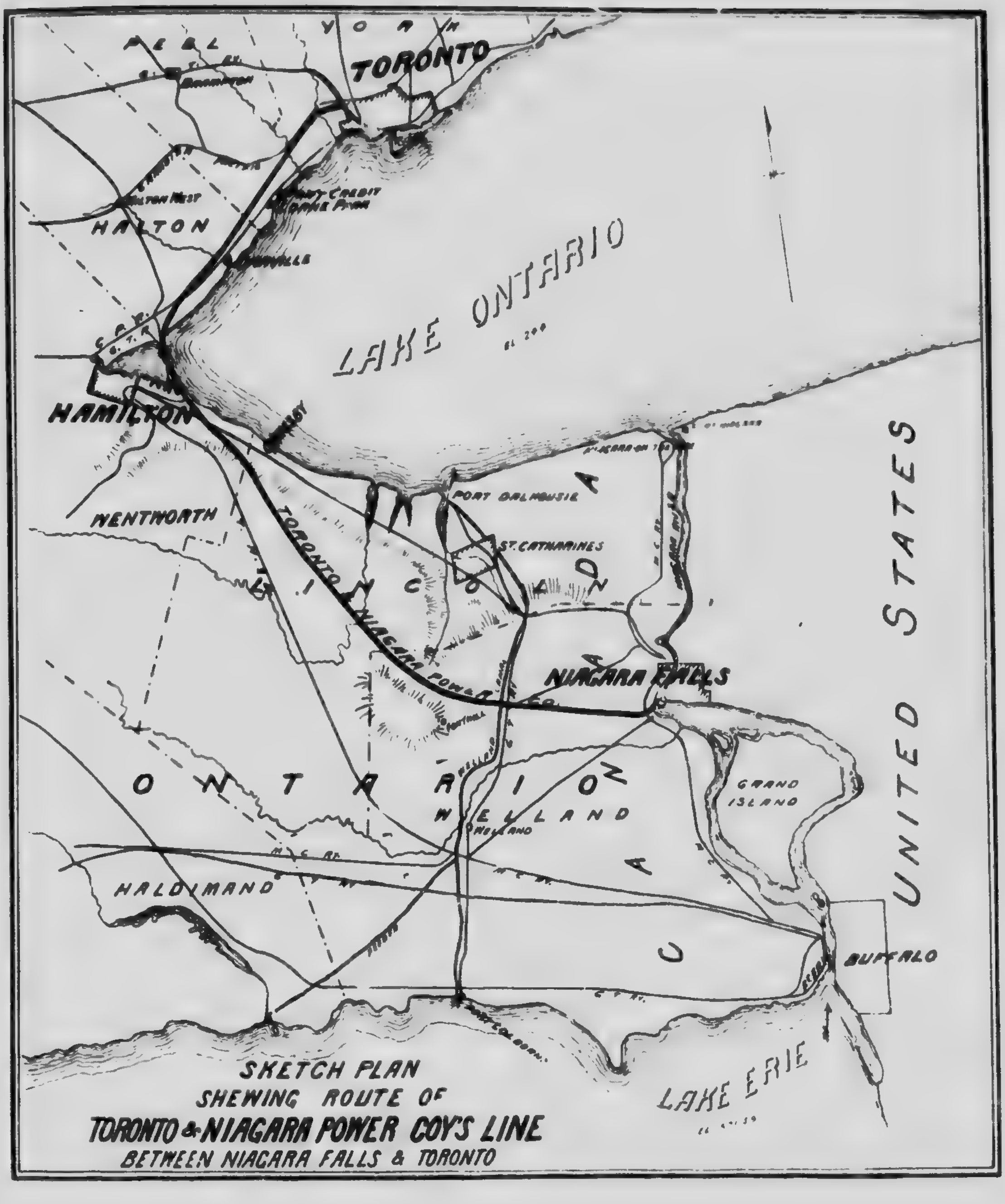
H. H. MACRAE,

Solicitor for Companies.



PLAN
SHEWING
MANUFACTURING SITES
OWNED BY THE
ELECTRICAL DEVELOPEMENT Co. of ONTARIO
(LIMITED)
BEING DISTANT ABOUT 3 MILES
FROM NIAGARA FALLS
AND HAVING A FRONTAGE ON THE
WELLAND RIVER
OF 1½ MILES, AND CONTAINING
AN AREA OF ABOUT 600 ACRES

SCALE 75 CHAINS PER INCH



SKETCH PLAN
SHEWING ROUTE OF
TORONTO & NIAGARA POWER COY'S LINE
BETWEEN NIAGARA FALLS & TORONTO

FREDERIC NICHOLLS, ESQ., Vice-President and General Manager
Electrical Development Co. of Ontario, Ltd., Toronto, Ont.

Dear Sir. In accordance with your instructions I herewith send you preliminary sketch for your Company's power house at Niagara. Receiving instructions to prepare a design that would be characteristic in appearance and answer the purpose for a power house and at the same time have a good appearance from the Park side, I have submitted a design that in my opinion will answer this purpose.

After due consideration I decided to adopt a classic form of architecture, therefore I have designed the building in the style of Italian Renaissance, believing this style of architecture to be one of the most adaptable to answer the purposes designated. The building will be about 500 feet long and 70 feet wide, and have an elevation of about 40 feet in height. The front elevation will have a centre and two end bays and the spaces between centre and end bays of the facades will be set back about six feet with large windows and forming a loggia. In the front of this loggia will be formed a colonnade bringing out the upper portion of the building with a proper proportioned entablature, balustrading, etc. The main wall behind the colonnade will be carried up above the balustrading several feet to receive the roof, the floor of the loggia will be raised three steps. The intention is that the public may pass in through the colonnade and along the loggia to look down into the machinery room. The centre bay will be enhanced by a portico which will be in keeping with the architecture lines of the colonnade with entablature, etc., and this bay will be further enhanced by being carried up several feet above the main roof. The end bays of the building will be similar to centre bay, formed semi-circular and projecting and have colonnade around curve of same to give similar effect to the front colonnade and for the purpose that the public can look down through large window openings and have an end view of the interior of the building. The rear facade of the building next the river to be finished plain.

It is the intention to form around the building a wide terrace that will lift the building up above the roadway level several feet and to form ascending steps to same that will be continued around the several sides of the terrace enhanced here and there with parapets which will be finished off with handsome lamp posts. The top of the terrace leading from the steps to the building will be laid out with paved walks, sodded and formed with flower beds so that when the building is finally completed it will have the appearance of being set up above the surrounding level, which will have a handsome appearance from the park.

In connection with the building, might say that it is the intention generally speaking to build it of light granite, not to have any unnecessary elaboration but to emphasize its beauty by pure architectural lines and proportions so that when the building is completed it will have a characteristic appearance to answer the purpose for which it is intended, namely, a power house.

Yours very truly,

E. J. LENNOX, *Architect*

EXTRACT FROM THE TORONTO EVENING NEWS, NOVEMBER 3rd, 1903.

DEED OF DARING FAILED IN OBJECT.

Perilous Trip of Workmen in Niagara Falls Tunnel.

THREE GALLANT MEN

Essayed to Solve a Problem for the Toronto and Niagara Power Company's Contractor.

From Our Own Correspondent.

Niagara Falls, Nov. 3.—Deeds of daring have been features of the construction of the electrical development works here ever since the first contractor started to work. The other day another feat was added to the list.

The scene of the latest exploit was the construction tunnel of A. C. Douglass, who has the contract for the great tunnel of the Toronto and Niagara Power Company—the largest of all Niagara's subterranean tail races.

The Toronto and Niagara Company's tunnel is to extend from the power house at Tempest Point, near the Dufferin Islands, to the foot of the centre of the Horseshoe Falls, a total length of 2,200 feet, the whole of which is upwards of 150 feet below the wildest part of the rapids above the Falls. In order to get at this work Contractor Douglass has driven a construction tunnel from a shaft on shore to the point where the power tunnel will empty its flood into the seething cauldron at the foot of the cataract. Some time ago this tunnel had advanced so far that only a thin wall of rock separated the heading from the chamber which exists back of the curtain of water. Then a hole was made through the wall at the top of the top tunnel. Immediately dense clouds of spray rushed in through the opening and water began to rise on the floor of the tunnel. Examination showed that to open the end of the tunnel down to the floor so that the water would run out would necessitate the removal of a large amount of rock. Powerful pumps were set to work to keep the water down, but the [illegible] was beyond them, and the water rose and drove the men from the headings. The pumps were powerless to keep it down, and it crept steadily up till there was such a depth in the whole tunnel that only a small space remained between it and the roof.

If the rock at the tunnel's mouth, which acted as a dam, could be removed the water would immediately run out, but how to get that rock away was a puzzle

Finally a daring scheme was hit upon, and three foremen, John Davis, Michael Abbott and "Shorty" Minor, volunteered for a most dangerous service.

A flat bottomed boat was procured from the Maid of the Mist Steamboat Company, and taken down the shaft to the end of the flooded tunnel. It rode so high in the water that it would not clear the roof and ballast was put in to make it ride lower. Then into the crazy craft got Davis, Abbott and Minor, with three boxes of dynamite and a lot of copper wire, and, lying on their backs and propelling the boat by pushing with hands and feet against the rugged roof, they started on a hair raising voyage.

The tunnel was, of course, in total darkness, save for their feeble torches. Below them was a rickety punt, floating in many feet of black, cold water. A few inches from their upturned faces was the solid rock lying a hundred and fifty feet thick above them, and over that reared the resistless flood of the rapids. Let those who have worked underground try to picture the position of these men, no one else can appreciate it.

The tunnel is many hundred feet long, and the progress of the boat was necessarily slow, but at last the venturesome voyageurs arrived at the heading of the tunnel and the hole through the rock which admitted a blast of strangling spray from the thunder of water on the rock outside.

One by one they crawled through the hole and stood, half stunned and borne down by the roar and pressure of imprisoned air, in the most wonderful chamber in the world.

They had no time to look around or analyze their sensations. With careful haste they placed the boxes of dynamite so as to form the most effective blast in the dam of rock which was causing all the trouble. They had to struggle constantly against the blasts of spray-laden air which rushed to and fro behind the falls, and at times were even forced off their feet.

At last the shot was placed, the wires connected, and the men crawled back through the hole and started for the shaft in the boat.

The end of the trip was safely reached, and the electric battery discharged the blast they had set. Again the men entered the boat to go to see the effect, but the boat went down under them, and they were forced to swim for their lives back to the shaft. A raft was built and tried, but it was a failure, and a second voyage through the tunnel was given up.

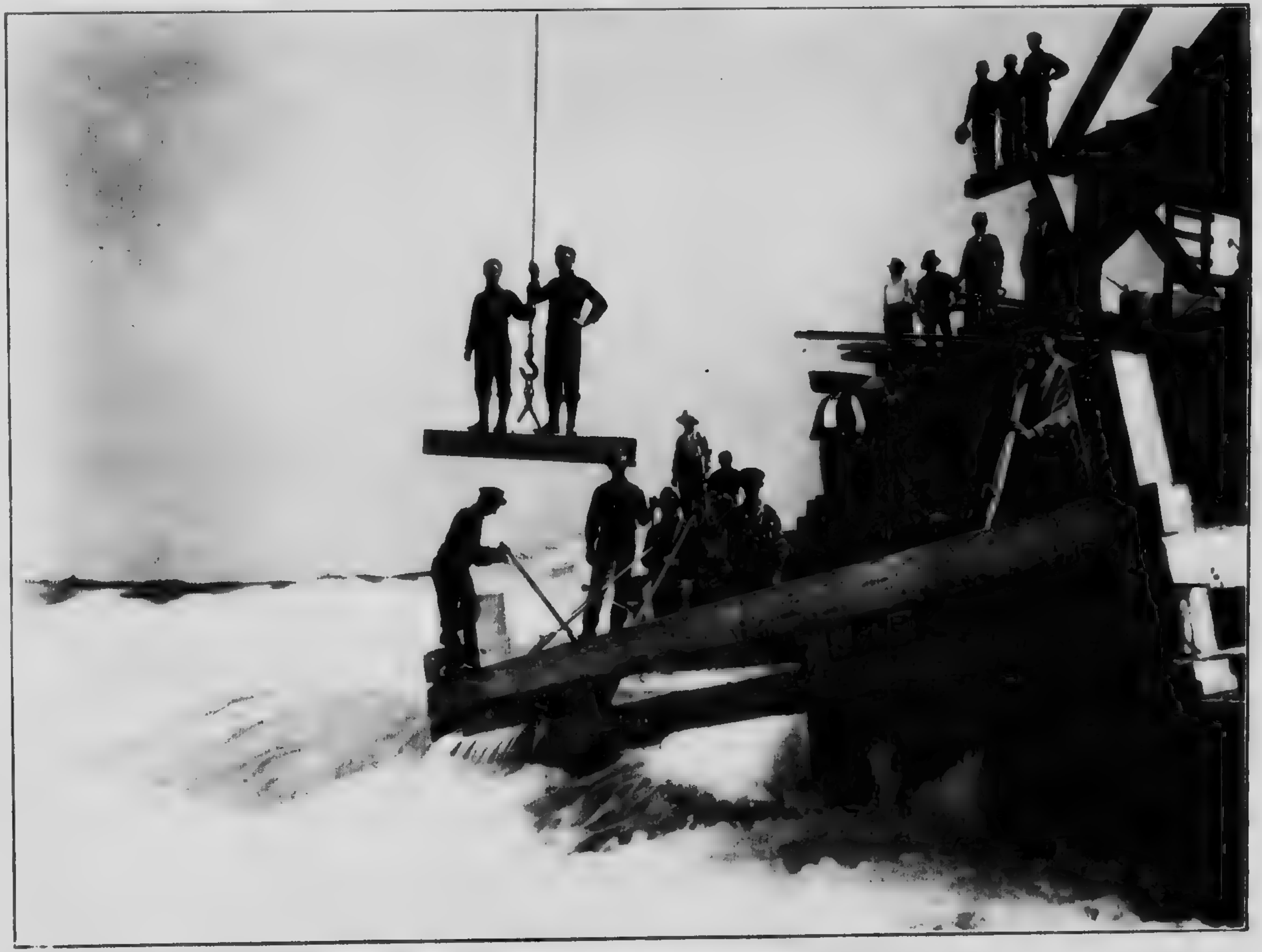
Later in the day Foreman Davis went behind the falls by way of the new scenic tunnel and made a perilous trip along the chamber to the mouth of the construction tunnel. He found that the blast had dug a big hole in the rock, but done little towards removing the mass that dams the tunnel's mouth. Worst of all, it had enlarged the opening into the tunnel, so that the spray went in faster than ever, but not enough to let one drop of water run out.

Contractor Douglas has a difficult task before him in removing the obstruction from the mouth of the tunnel, but considering the men he has to carry out his plans, it is safe to say he will accomplish it soon.

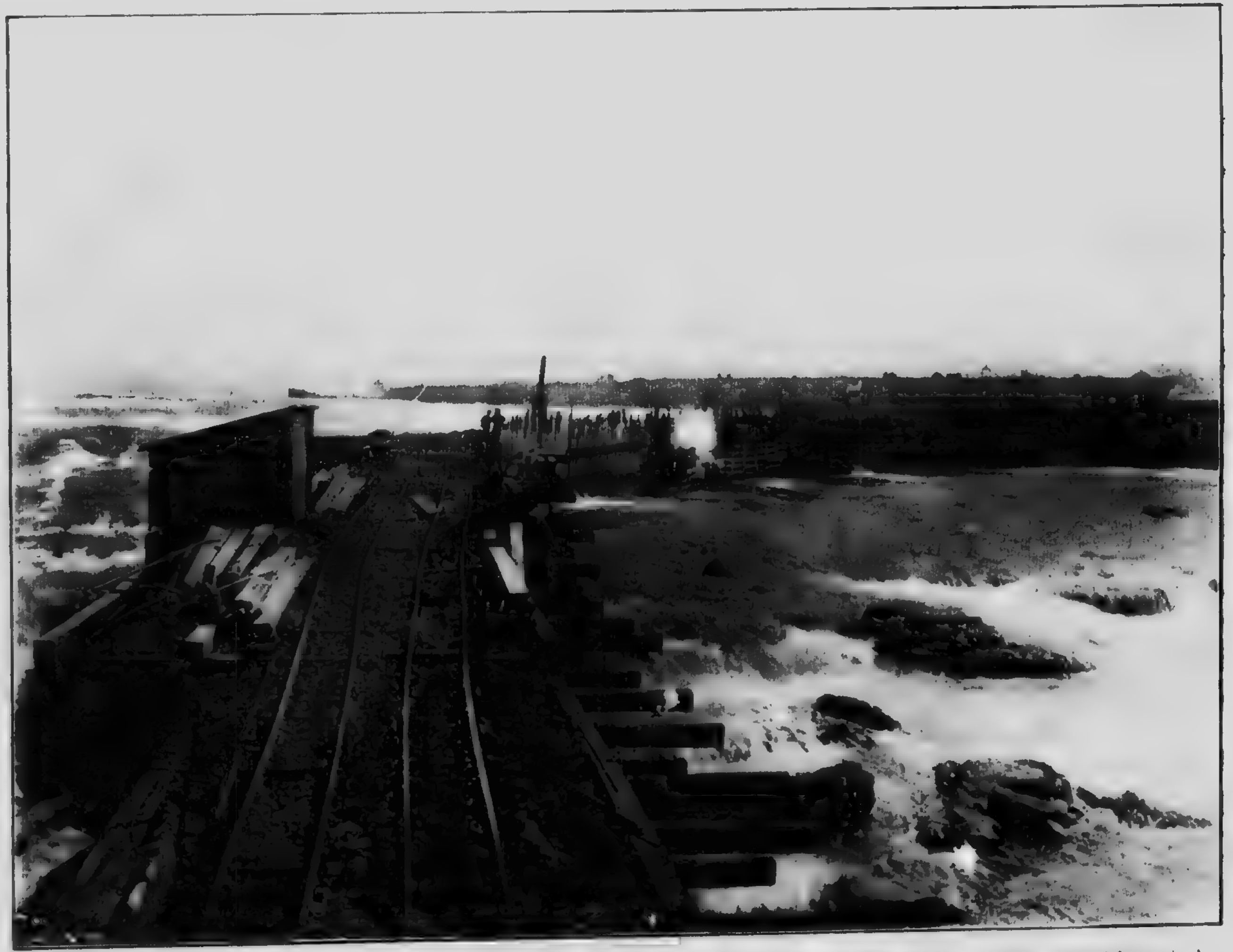
Difficulties mentioned above were successfully surmounted two or three days after publication of the above article.

FREDERIC NICHOLLS,

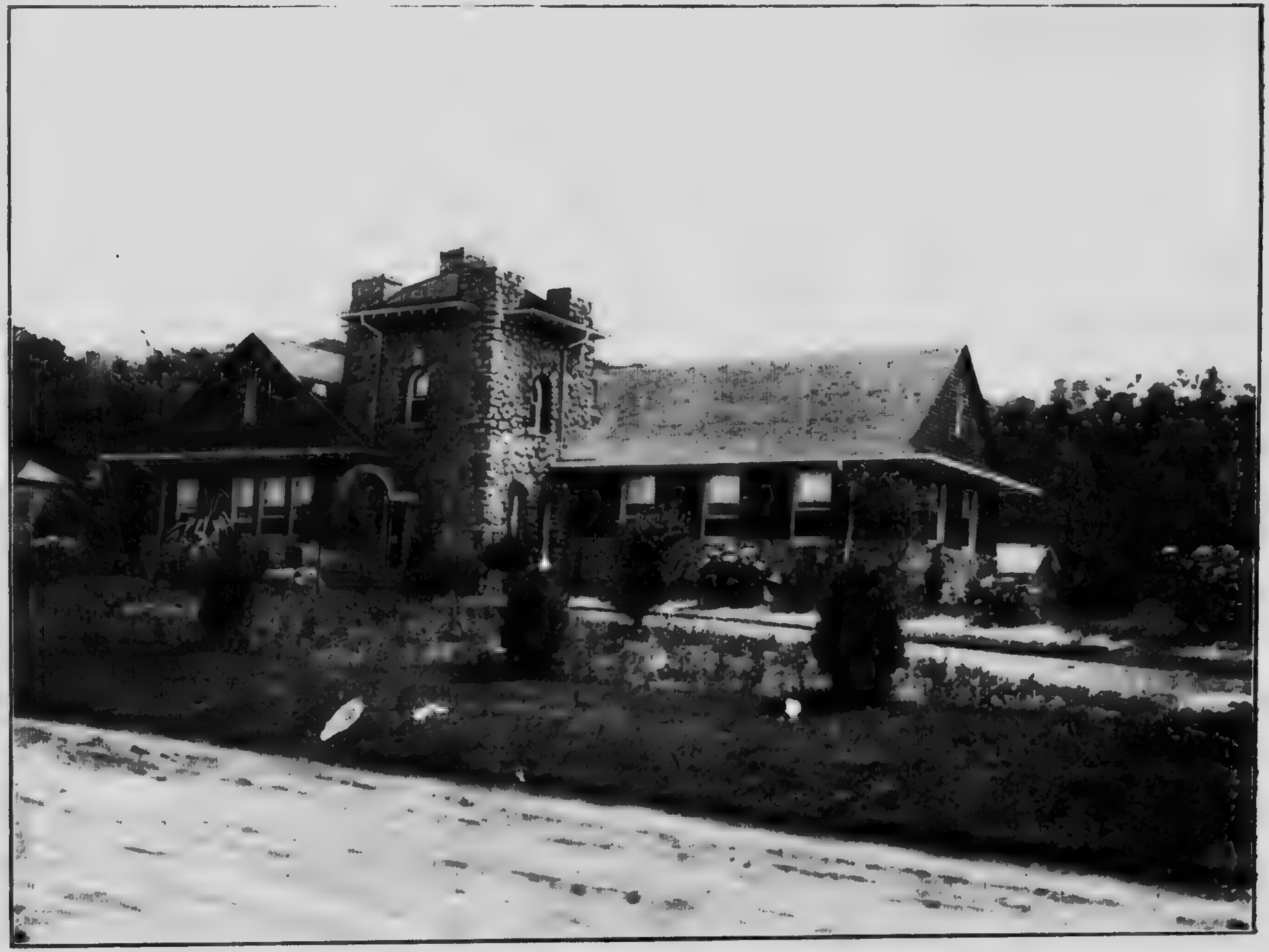
Vice-President and General Manager.



Photograph showing Cascade and launching of a crib. It was at this point that the only fatal accident during construction of the crib occurred; one of the workmen who fell into the river being carried over the falls



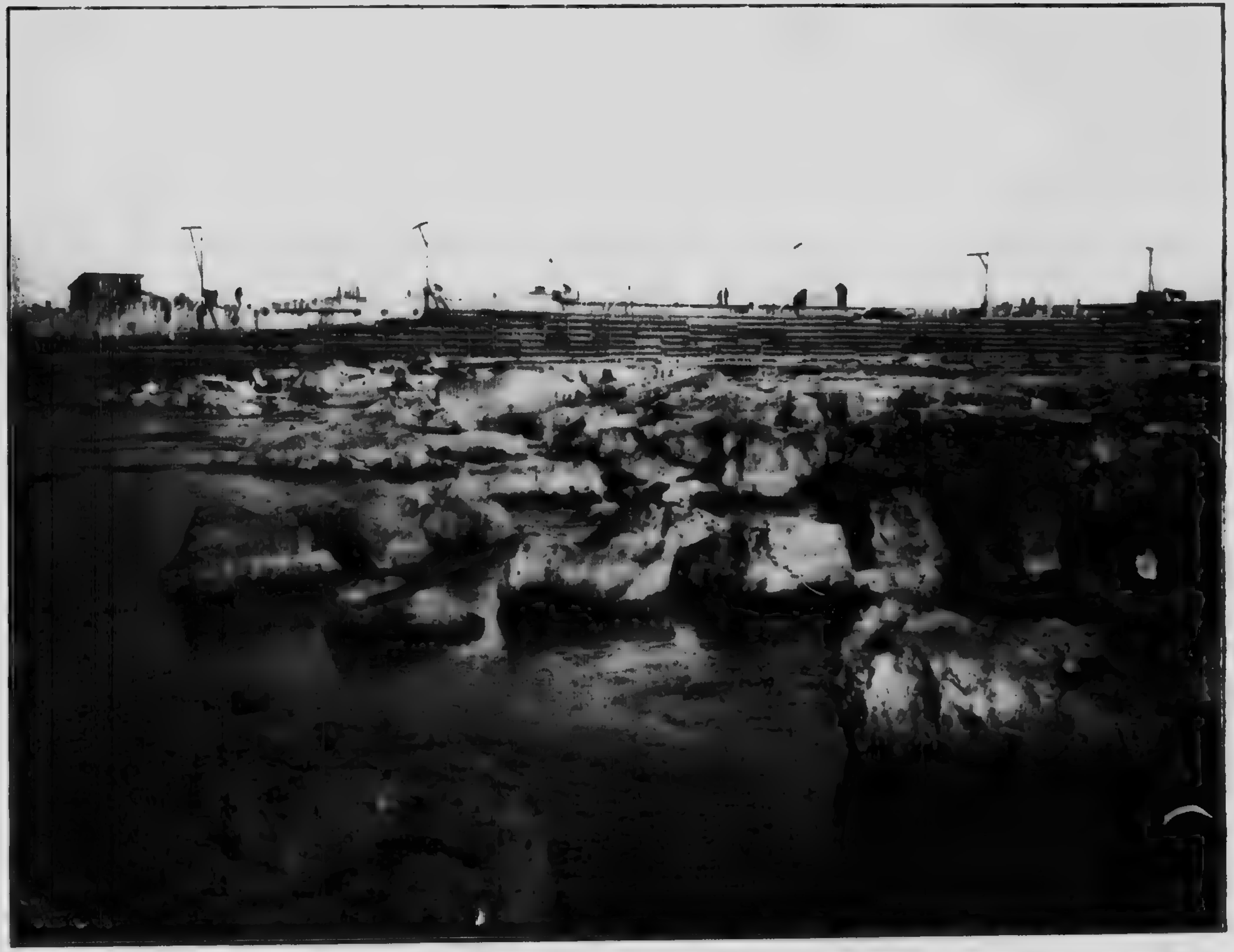
Photograph of Main Coffer Dam showing arched form of construction. A double track line of standard guage is used to bring materials required in construction, such as timber, rock, clay, etc.



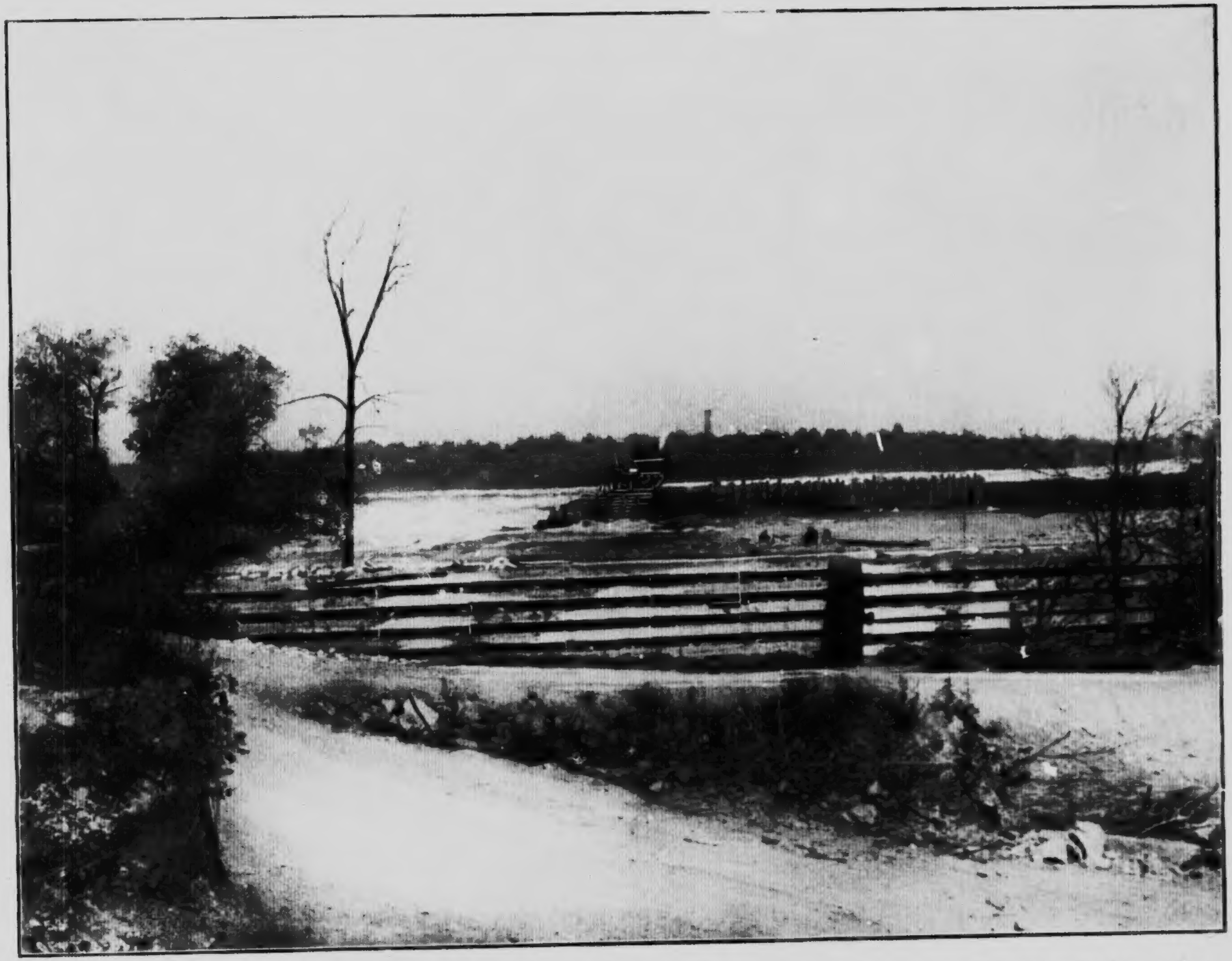
NIAGARA FALLS OFFICE.

The Resident Engineer and his staff of assistants are located here, the office building being within a few hundred feet of the works. The wing to the right of the photograph is a large draughting room. Cement testing and other laboratory work is provided for in the cellar. A Directors' meeting room is in the second story of the tower. Bond & Smith, Architects.

Site of Power House and Wheel Pit, surrounded by subsidiary Coffer Dam. The Wheel Pit Excavation will be covered by a rough building so that construction can proceed night and day irrespective of the weather. This site was covered by water to an average depth of 7 feet.



Photograph showing successful unwatering of Cascade rapids between the main and subsidiary Coffer Dams. On the farther side of the main Coffer Dam is the most turbulent rapid in the Upper Niagara River. The contour of the river bed gives some idea of the difficulties experienced in securing stable foundations for the Dam. The depth of water encountered at this point was fourteen to fifteen feet.



Photograph showing arched construction of main Coffer Dam, which adds materially to its stability. From the end anchored to the shore to the end under construction at the foot of second cascade it will be seen that the arch form of construction has been maintained.

Photograph of Main Coffer Dam just below the second cascade. Construction was both difficult and dangerous. The depth of water at this point is about nineteen feet. The width of the Main Crib is twenty four feet, [illegible] crib of sixteen feet separated by a clay puddle space of six feet.